```
!python -m pip install
'git+https://github.com/facebookresearch/detectron2.git'

Collecting git+https://github.com/facebookresearch/detectron2.git
  Cloning https://github.com/facebookresearch/detectron2.git to
/tmp/pip-req-build-7fa8zt8u
  Running command git clone --filter=blob:none --quiet
https://github.com/facebookresearch/detectron2.git /tmp/pip-req-build-
7fa8zt8u
  Resolved https://github.com/facebookresearch/detectron2.git to
commit 57bdb21249d5418c130d54e2ebdc94dda7a4c01a
  Preparing metadata (setup.py) ... ent already satisfied: Pillow>=7.1
in /usr/local/lib/python3.10/dist-packages (from detectron2==0.6)
(9.4.0)
Requirement already satisfied: matplotlib in
/usr/local/lib/python3.10/dist-packages (from detectron2==0.6) (3.7.1)
Requirement already satisfied: pycocotools>=2.0.2 in
/usr/local/lib/python3.10/dist-packages (from detectron2==0.6) (2.0.6)
Requirement already satisfied: termcolor>=1.1 in
/usr/local/lib/python3.10/dist-packages (from detectron2==0.6) (2.3.0)
Collecting yacs>=0.1.8 (from detectron2==0.6)
  Downloading yacs-0.1.8-py3-none-any.whl (14 kB)
Requirement already satisfied: tabulate in
/usr/local/lib/python3.10/dist-packages (from detectron2==0.6) (0.9.0)
Requirement already satisfied: cloudpickle in
/usr/local/lib/python3.10/dist-packages (from detectron2==0.6) (2.2.1)
Requirement already satisfied: tqdm>4.29.0 in
/usr/local/lib/python3.10/dist-packages (from detectron2==0.6)
(4.65.0)
Requirement already satisfied: tensorboard in
/usr/local/lib/python3.10/dist-packages (from detectron2==0.6)
(2.12.3)
Collecting fvcore<0.1.6,>=0.1.5 (from detectron2==0.6)
  Downloading fvcore-0.1.5.post20221221.tar.gz (50 kB)
━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 50.2/50.2 kB 2.3 MB/s eta
0:00:00
etadata (setup.py) ...  detectron2==0.6)
  Downloading iopath-0.1.9-py3-none-any.whl (27 kB)
Collecting omegaconf>=2.1 (from detectron2==0.6)
  Downloading omegaconf-2.3.0-py3-none-any.whl (79 kB)
━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 79.5/79.5 kB 3.9 MB/s eta
0:00:00
 detectron2==0.6)
  Downloading hydra_core-1.3.2-py3-none-any.whl (154 kB)
━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 154.5/154.5 kB 16.4 MB/s eta
0:00:00
 detectron2==0.6)
  Downloading black-23.7.0-cp310-cp310-
manylinux_2_17_x86_64.manylinux2014_x86_64.whl (1.7 MB)
━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 1.7/1.7 MB 8.8 MB/s eta
```

```
0:00:00
ent already satisfied: packaging in /usr/local/lib/python3.10/dist-
packages (from detectron2==0.6) (23.1)
Requirement already satisfied: numpy in
/usr/local/lib/python3.10/dist-packages (from fvcore<0.1.6,>=0.1.5-
>detectron2==0.6) (1.22.4)
Requirement already satisfied: pyyaml>=5.1 in
/usr/local/lib/python3.10/dist-packages (from fvcore<0.1.6,>=0.1.5-
>detectron2==0.6) (6.0.1)
Collecting antlr4-python3-runtime==4.9.* (from hydra-core>=1.1-
>detectron2==0.6)
  Downloading antlr4-python3-runtime-4.9.3.tar.gz (117 kB)
━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 117.0/117.0 kB 13.8 MB/s eta
0:00:00
etadata (setup.py) ...  iopath<0.1.10,>=0.1.7->detectron2==0.6)
  Downloading portalocker-2.7.0-py2.py3-none-any.whl (15 kB)
Requirement already satisfied: contourpy>=1.0.1 in
/usr/local/lib/python3.10/dist-packages (from matplotlib-
>detectron2==0.6) (1.1.0)
Requirement already satisfied: cycler>=0.10 in
/usr/local/lib/python3.10/dist-packages (from matplotlib-
>detectron2==0.6) (0.11.0)
Requirement already satisfied: fonttools>=4.22.0 in
/usr/local/lib/python3.10/dist-packages (from matplotlib-
>detectron2==0.6) (4.41.1)
Requirement already satisfied: kiwisolver>=1.0.1 in
/usr/local/lib/python3.10/dist-packages (from matplotlib-
>detectron2==0.6) (1.4.4)
Requirement already satisfied: pyparsing>=2.3.1 in
/usr/local/lib/python3.10/dist-packages (from matplotlib-
>detectron2==0.6) (3.1.0)
Requirement already satisfied: python-dateutil>=2.7 in
/usr/local/lib/python3.10/dist-packages (from matplotlib-
>detectron2==0.6) (2.8.2)
Requirement already satisfied: click>=8.0.0 in
/usr/local/lib/python3.10/dist-packages (from black->detectron2==0.6)
(8.1.6)
Collecting mypy-extensions>=0.4.3 (from black->detectron2==0.6)
  Downloading mypy_extensions-1.0.0-py3-none-any.whl (4.7 kB)
Collecting pathspec>=0.9.0 (from black->detectron2==0.6)
  Downloading pathspec-0.11.2-py3-none-any.whl (29 kB)
Requirement already satisfied: platformdirs>=2 in
/usr/local/lib/python3.10/dist-packages (from black->detectron2==0.6)
(3.9.1)
Requirement already satisfied: tomli>=1.1.0 in
/usr/local/lib/python3.10/dist-packages (from black->detectron2==0.6)
(2.0.1)
Requirement already satisfied: absl-py>=0.4 in
/usr/local/lib/python3.10/dist-packages (from tensorboard-
```

```
>detectron2==0.6) (1.4.0)
Requirement already satisfied: grpcio>=1.48.2 in
/usr/local/lib/python3.10/dist-packages (from tensorboard-
>detectron2==0.6) (1.56.2)
Requirement already satisfied: google-auth<3,>=1.6.3 in
/usr/local/lib/python3.10/dist-packages (from tensorboard-
>detectron2==0.6) (2.17.3)
Requirement already satisfied: google-auth-oauthlib<1.1,>=0.5 in
/usr/local/lib/python3.10/dist-packages (from tensorboard-
>detectron2==0.6) (1.0.0)
Requirement already satisfied: markdown>=2.6.8 in
/usr/local/lib/python3.10/dist-packages (from tensorboard-
>detectron2==0.6) (3.4.4)
Requirement already satisfied: protobuf>=3.19.6 in
/usr/local/lib/python3.10/dist-packages (from tensorboard-
>detectron2==0.6) (3.20.3)
Requirement already satisfied: requests<3,>=2.21.0 in
/usr/local/lib/python3.10/dist-packages (from tensorboard-
>detectron2==0.6) (2.27.1)
Requirement already satisfied: setuptools>=41.0.0 in
/usr/local/lib/python3.10/dist-packages (from tensorboard-
>detectron2==0.6) (67.7.2)
Requirement already satisfied: tensorboard-data-server<0.8.0,>=0.7.0
in /usr/local/lib/python3.10/dist-packages (from tensorboard-
>detectron2==0.6) (0.7.1)
Requirement already satisfied: werkzeug>=1.0.1 in
/usr/local/lib/python3.10/dist-packages (from tensorboard-
>detectron2==0.6) (2.3.6)
Requirement already satisfied: wheel>=0.26 in
/usr/local/lib/python3.10/dist-packages (from tensorboard-
>detectron2==0.6) (0.41.0)
Requirement already satisfied: cachetools<6.0,>=2.0.0 in
/usr/local/lib/python3.10/dist-packages (from google-auth<3,>=1.6.3-
>tensorboard->detectron2==0.6) (5.3.1)
Requirement already satisfied: pyasn1-modules>=0.2.1 in
/usr/local/lib/python3.10/dist-packages (from google-auth<3,>=1.6.3-
>tensorboard->detectron2==0.6) (0.3.0)
Requirement already satisfied: six>=1.9.0 in
/usr/local/lib/python3.10/dist-packages (from google-auth<3,>=1.6.3-
>tensorboard->detectron2==0.6) (1.16.0)
Requirement already satisfied: rsa<5,>=3.1.4 in
/usr/local/lib/python3.10/dist-packages (from google-auth<3,>=1.6.3-
>tensorboard->detectron2==0.6) (4.9)
Requirement already satisfied: requests-oauthlib>=0.7.0 in
/usr/local/lib/python3.10/dist-packages (from google-auth-
oauthlib<1.1,>=0.5->tensorboard->detectron2==0.6) (1.3.1)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in
/usr/local/lib/python3.10/dist-packages (from requests<3,>=2.21.0-
>tensorboard->detectron2==0.6) (1.26.16)
```

```
Requirement already satisfied: certifi>=2017.4.17 in
/usr/local/lib/python3.10/dist-packages (from requests<3,>=2.21.0-
>tensorboard->detectron2==0.6) (2023.7.22)
Requirement already satisfied: charset-normalizer~=2.0.0 in
/usr/local/lib/python3.10/dist-packages (from requests<3,>=2.21.0-
>tensorboard->detectron2==0.6) (2.0.12)
Requirement already satisfied: idna<4,>=2.5 in
/usr/local/lib/python3.10/dist-packages (from requests<3,>=2.21.0-
>tensorboard->detectron2==0.6) (3.4)
Requirement already satisfied: MarkupSafe>=2.1.1 in
/usr/local/lib/python3.10/dist-packages (from werkzeug>=1.0.1-
>tensorboard->detectron2==0.6) (2.1.3)
Requirement already satisfied: pyasn1<0.6.0,>=0.4.6 in
/usr/local/lib/python3.10/dist-packages (from pyasn1-modules>=0.2.1-
>google-auth<3,>=1.6.3->tensorboard->detectron2==0.6) (0.5.0)
Requirement already satisfied: oauthlib>=3.0.0 in
/usr/local/lib/python3.10/dist-packages (from requests-
oauthlib>=0.7.0->google-auth-oauthlib<1.1,>=0.5->tensorboard-
>detectron2==0.6) (3.2.2)
Building wheels for collected packages: detectron2, fvcore, antlr4-
python3-runtime
  Building wheel for detectron2 (setup.py) ... e=detectron2-0.6-cp310-
cp310-linux_x86_64.whl size=6114273
sha256=890fd69a15e0eb2d3f7ab4e791f01f9f8106d33f7c951c8e19c7efa88462bf1
3
  Stored in directory:
/tmp/pip-ephem-wheel-cache-xe80_v5k/wheels/47/e5/15/94c80df2ba85500c5d
76599cc307c0a7079d0e221bb6fc4375
  Building wheel for fvcore (setup.py) ... e=fvcore-
0.1.5.post20221221-py3-none-any.whl size=61406
sha256=d467390c2a64258d426f5658e611ba075ea1b45eef6df94bb3de577571b01cf
8
  Stored in directory:
/root/.cache/pip/wheels/01/c0/af/77c1cf53a1be9e42a52b48e5af2169d40ec2e
89f7362489dd0
  Building wheel for antlr4-python3-runtime (setup.py) ... e:
filename=antlr4_python3_runtime-4.9.3-py3-none-any.whl size=144552
sha256=e3158445410dc4e2e525411c29acb8324e74daf65b6b81beb5ce18197a28813
2
  Stored in directory:
/root/.cache/pip/wheels/12/93/dd/1f6a127edc45659556564c5730f6d4e300888
f4bca2d4c5a88
Successfully built detectron2 fvcore antlr4-python3-runtime
Installing collected packages: antlr4-python3-runtime, yacs,
portalocker, pathspec, omegaconf, mypy-extensions, iopath, hydra-core,
black, fvcore, detectron2
Successfully installed antlr4-python3-runtime-4.9.3 black-23.7.0
detectron2-0.6 fvcore-0.1.5.post20221221 hydra-core-1.3.2 iopath-0.1.9
```

```
mypy-extensions-1.0.0 omegaconf-2.3.0 pathspec-0.11.2 portalocker-
2.7.0 yacs-0.1.8
```

```
import sys
print("User Current Version:-", sys.version)
```

```
User Current Version:- 3.10.6 (main, May 29 2023, 11:10:38) [GCC
11.3.0]
```

```
from platform import python_version
print("Current Python Version-", python_version())
```

```
Current Python Version- 3.10.6
```

```
!python -m pip install pyyaml==5.1
```

```
Collecting pyyaml==5.1
  Downloading PyYAML-5.1.tar.gz (274 kB)
━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 0.0/274.2 kB ? eta -:--:--
━━━━━━━━━━━━━━━ ━━━━━━━━━━━━━━━━━━━━━━━ 112.6/274.2 kB 3.1 MB/s eta
0:00:01 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 274.2/274.2 kB 4.8
MB/s eta 0:00:00
etadata (setup.py) ... l
  Building wheel for pyyaml (setup.py) ... l: filename=PyYAML-5.1-
cp310-cp310-linux_x86_64.whl size=44091
sha256=503bddfd5d9fb599a6efdf51f06c435c1472231b5667bf54a1fc507f2857855
1
  Stored in directory:
/root/.cache/pip/wheels/70/83/31/975b737609aba39a4099d471d5684141c1fdc
3404f97e7f68a
Successfully built pyyaml
Installing collected packages: pyyaml
  Attempting uninstall: pyyaml
    Found existing installation: PyYAML 6.0.1
    Uninstalling PyYAML-6.0.1:
      Successfully uninstalled PyYAML-6.0.1
ERROR: pip's dependency resolver does not currently take into account
all the packages that are installed. This behaviour is the source of
the following dependency conflicts.
dask 2022.12.1 requires pyyaml>=5.3.1, but you have pyyaml 5.1 which
is incompatible.
flax 0.7.0 requires PyYAML>=5.4.1, but you have pyyaml 5.1 which is
incompatible.
Successfully installed pyyaml-5.1
```

```
import torch, detectron2
!nvcc --version
TORCH_VERSION = ".".join(torch.__version__.split(".")[:2])
CUDA_VERSION = torch.__version__.split("+")[-1]
print("torch: ", TORCH_VERSION, "; cuda: ", CUDA_VERSION)
print("detectron2:", detectron2.__version__)
```

```
nvcc: NVIDIA (R) Cuda compiler driver
Copyright (c) 2005-2022 NVIDIA Corporation
Built on Wed_Sep_21_10:33:58_PDT_2022
Cuda compilation tools, release 11.8, V11.8.89
Build cuda_11.8.r11.8/compiler.31833905_0
torch:  2.0 ; cuda:  cu118
detectron2: 0.6
```

```
import detectron2
from detectron2.utils.logger import setup_logger
setup_logger()

# import some common libraries
import numpy as np
import cv2
import matplotlib.pyplot as plt

# import some common detectron2 utilities
from detectron2 import model_zoo
from detectron2.engine import DefaultPredictor
from detectron2.config import get_cfg
from detectron2.utils.visualizer import Visualizer
from detectron2.data import MetadataCatalog, DatasetCatalog
```

```
from google.colab import drive
drive.mount('/content/drive')
```

```
Drive already mounted at /content/drive; to attempt to forcibly
remount, call drive.mount("/content/drive", force_remount=True).
```

```
 !ls '/content/drive/MyDrive/Mahabub'
```

```
average_areas.txt  crack_info.txt  test  train
```

```
!ls '/content/drive/MyDrive/Mahabub/train'
```

```
rsz_1slm_square_finalx15k_0001.jpg   rsz_slm_square_finalx15k_0013.jpg
rsz_1slm_square_finalx15k_0001.json
rsz_slm_square_finalx15k_0013.json
rsz_1slm_square_finalx15k_0006.jpg   rsz_slm_square_finalx15k_0014.jpg
rsz_1slm_square_finalx15k_0006.json
rsz_slm_square_finalx15k_0014.json
rsz_1slm_square_finalx15k_0007.jpg   rsz_slm_square_finalx15k_0016.jpg
rsz_1slm_square_finalx15k_0007.json
rsz_slm_square_finalx15k_0016.json
rsz_1slm_square_finalx15k_0017.jpg   rsz_slm_square_finalx15k_0018.jpg
rsz_1slm_square_finalx15k_0017.json
rsz_slm_square_finalx15k_0018.json
rsz_1slm_square_finalx15k_0019.jpg   rsz_slm_square_finalx15k_0021.jpg
rsz_1slm_square_finalx15k_0019.json
rsz_slm_square_finalx15k_0021.json
```

```
rsz_1slm_square_finalx15k_0020.jpg   rsz_slm_square_finalx15k_0022.jpg
rsz_1slm_square_finalx15k_0020.json
rsz_slm_square_finalx15k_0022.json
rsz_1slm_square_finalx15k_0024.jpg   rsz_slm_square_finalx15k_0023.jpg
rsz_1slm_square_finalx15k_0024.json
rsz_slm_square_finalx15k_0023.json
rsz_1slm_square_finalx15k_0029.jpg   rsz_slm_square_finalx15k_0025.jpg
rsz_1slm_square_finalx15k_0029.json
rsz_slm_square_finalx15k_0025.json
rsz_1slm_square_finalx15k_0031.jpg   rsz_slm_square_finalx15k_0026.jpg
rsz_1slm_square_finalx15k_0031.json
rsz_slm_square_finalx15k_0026.json
rsz_1slm_square_finalx15k_0032.jpg   rsz_slm_square_finalx15k_0027.jpg
rsz_1slm_square_finalx15k_0032.json
rsz_slm_square_finalx15k_0027.json
rsz_1slm_square_finalx15k_0040.jpg   rsz_slm_square_finalx15k_0028.jpg
rsz_1slm_square_finalx15k_0040.json
rsz_slm_square_finalx15k_0028.json
rsz_1slm_square_finalx15k_0059.jpg   rsz_slm_square_finalx15k_0030.jpg
rsz_1slm_square_finalx15k_0059.json
rsz_slm_square_finalx15k_0030.json
rsz_slm_square_finalx15k_0002.jpg    rsz_slm_square_finalx15k_0033.jpg
rsz_slm_square_finalx15k_0002.json
rsz_slm_square_finalx15k_0033.json
rsz_slm_square_finalx15k_0003.jpg    rsz_slm_square_finalx15k_0034.jpg
rsz_slm_square_finalx15k_0003.json
rsz_slm_square_finalx15k_0034.json
rsz_slm_square_finalx15k_0004.jpg    rsz_slm_square_finalx15k_0035.jpg
rsz_slm_square_finalx15k_0004.json
rsz_slm_square_finalx15k_0035.json
rsz_slm_square_finalx15k_0005.jpg    rsz_slm_square_finalx15k_0036.jpg
rsz_slm_square_finalx15k_0005.json
rsz_slm_square_finalx15k_0036.json
rsz_slm_square_finalx15k_0008.jpg    rsz_slm_square_finalx15k_0037.jpg
rsz_slm_square_finalx15k_0008.json
rsz_slm_square_finalx15k_0037.json
rsz_slm_square_finalx15k_0009.jpg    rsz_slm_square_finalx15k_0038.jpg
rsz_slm_square_finalx15k_0009.json
rsz_slm_square_finalx15k_0038.json
rsz_slm_square_finalx15k_0010.jpg    rsz_slm_square_finalx15k_0041.jpg
rsz_slm_square_finalx15k_0010.json
rsz_slm_square_finalx15k_0041.json
rsz_slm_square_finalx15k_0011.jpg    rsz_slm_square_finalx15k_0042.jpg
rsz_slm_square_finalx15k_0011.json
rsz_slm_square_finalx15k_0042.json
rsz_slm_square_finalx15k_0012.jpg    rsz_slm_square_finalx15k_0043.jpg
rsz_slm_square_finalx15k_0012.json
rsz_slm_square_finalx15k_0043.json
```

```
!ls '/content/drive/MyDrive/Mahabub/test'
```

```
rsz_1slm_square_finalx15k_0015.jpg   rsz_slm_square_finalx15k_0051.jpg
rsz_1slm_square_finalx15k_0015.json
rsz_slm_square_finalx15k_0051.json
rsz_1slm_square_finalx15k_0039.jpg   rsz_slm_square_finalx15k_0052.jpg
rsz_1slm_square_finalx15k_0039.json
rsz_slm_square_finalx15k_0052.json
rsz_1slm_square_finalx15k_0044.jpg   rsz_slm_square_finalx15k_0053.jpg
rsz_1slm_square_finalx15k_0044.json
rsz_slm_square_finalx15k_0053.json
rsz_slm_square_finalx15k_0045.jpg    rsz_slm_square_finalx15k_0054.jpg
rsz_slm_square_finalx15k_0045.json
rsz_slm_square_finalx15k_0054.json
rsz_slm_square_finalx15k_0046.jpg    rsz_slm_square_finalx15k_0055.jpg
rsz_slm_square_finalx15k_0046.json
rsz_slm_square_finalx15k_0055.json
rsz_slm_square_finalx15k_0047.jpg    rsz_slm_square_finalx15k_0056.jpg
rsz_slm_square_finalx15k_0047.json
rsz_slm_square_finalx15k_0056.json
rsz_slm_square_finalx15k_0048.jpg    rsz_slm_square_finalx15k_0057.jpg
rsz_slm_square_finalx15k_0048.json
rsz_slm_square_finalx15k_0057.json
rsz_slm_square_finalx15k_0049.jpg    rsz_slm_square_finalx15k_0058.jpg
rsz_slm_square_finalx15k_0049.json
rsz_slm_square_finalx15k_0058.json
rsz_slm_square_finalx15k_0050.jpg    rsz_slm_square_finalx15k_0060.jpg
rsz_slm_square_finalx15k_0050.json
rsz_slm_square_finalx15k_0060.json
```

```
DatasetCatalog.remove("p_train")
DatasetCatalog.remove("p_test")

import os
import numpy as np
import json
from detectron2.structures import BoxMode

def get_r_dicts(directory):

    classes = ['unmelted particle', 'porosity', 'microcrack']
    dataset_dicts = []
    for idx, filename in enumerate([file for file in
os.listdir(directory) if file.endswith('.json')]):
        json_file = os.path.join(directory, filename)
        with open(json_file) as f:
            img_anns = json.load(f)

        record = {}

        filename = os.path.join(directory, img_anns["imagePath"])
```

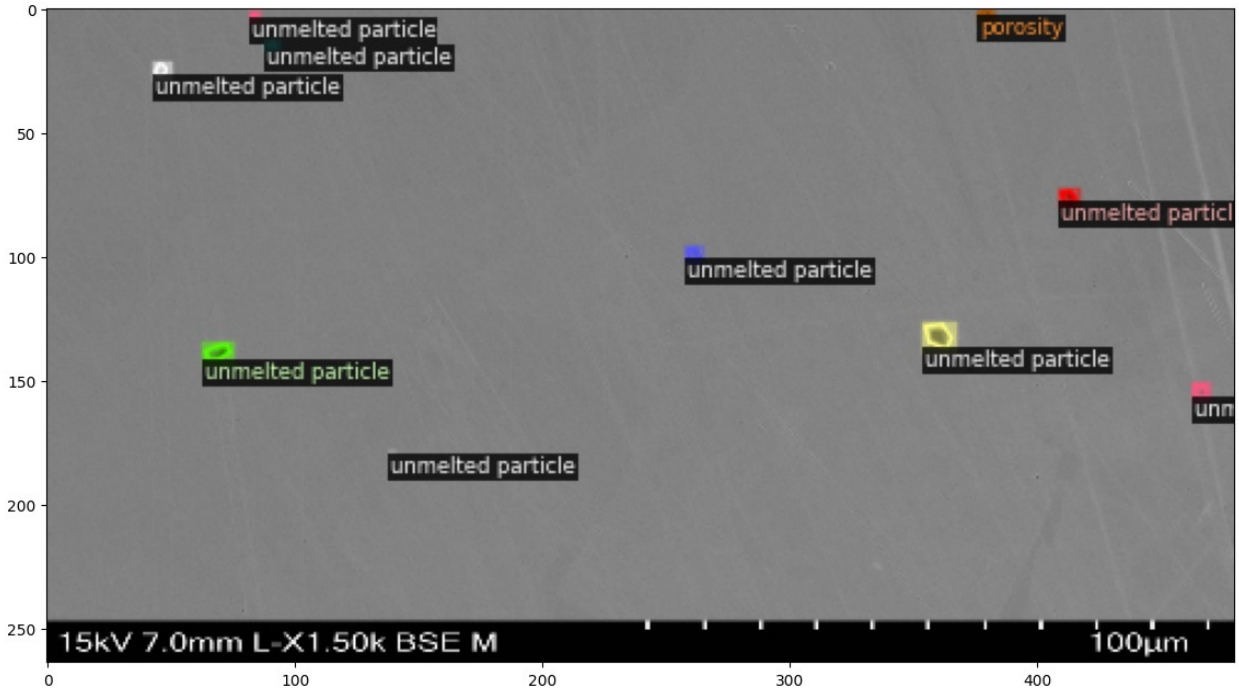
```
        record["file_name"] = filename
        record["image_id"] = idx
        record["height"] = 528
        record["width"] = 960

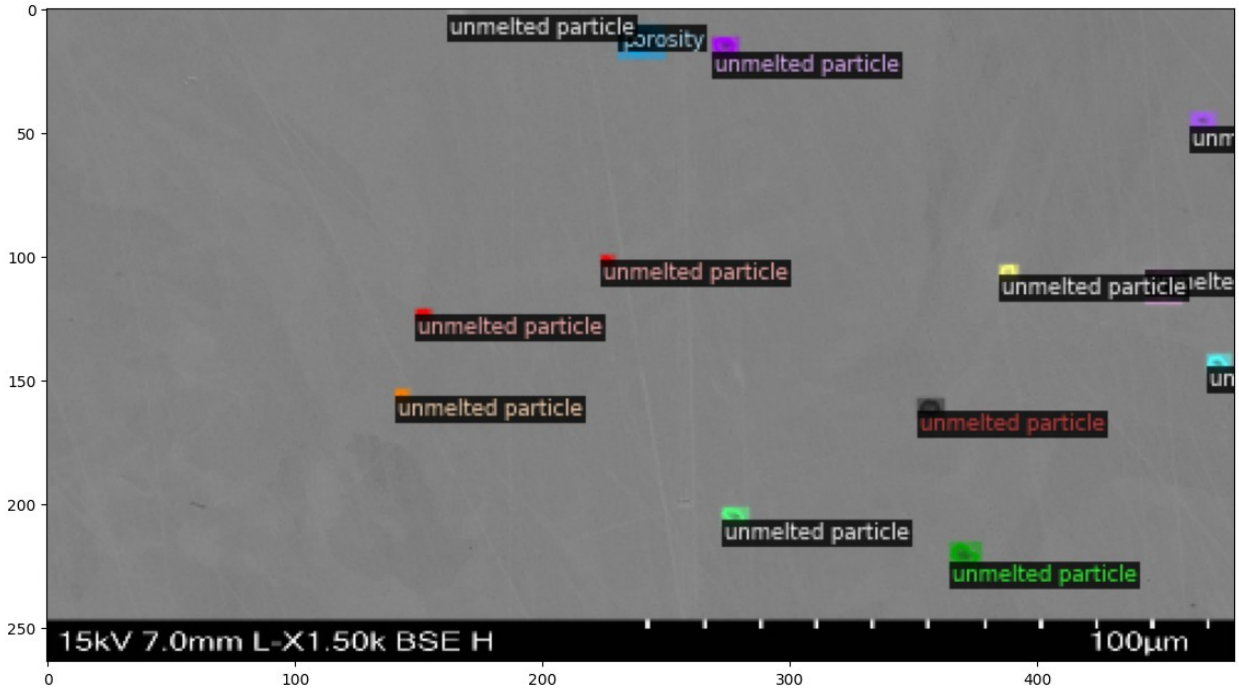
        annos = img_anns["shapes"]
        objs = []
        for anno in annos:
            px = [a[0] for a in anno['points']]
            py = [a[1] for a in anno['points']]
            poly = [(x, y) for x, y in zip(px, py)]
            poly = [p for x in poly for p in x]
            obj = {
                "bbox": [np.min(px), np.min(py), np.max(px),
np.max(py)],
                "bbox_mode": BoxMode.XYXY_ABS,
                "segmentation": [poly],
                "category_id": classes.index(anno['label']),
                "iscrowd": 0
            }
            objs.append(obj)
        record["annotations"] = objs
        dataset_dicts.append(record)
    return dataset_dicts

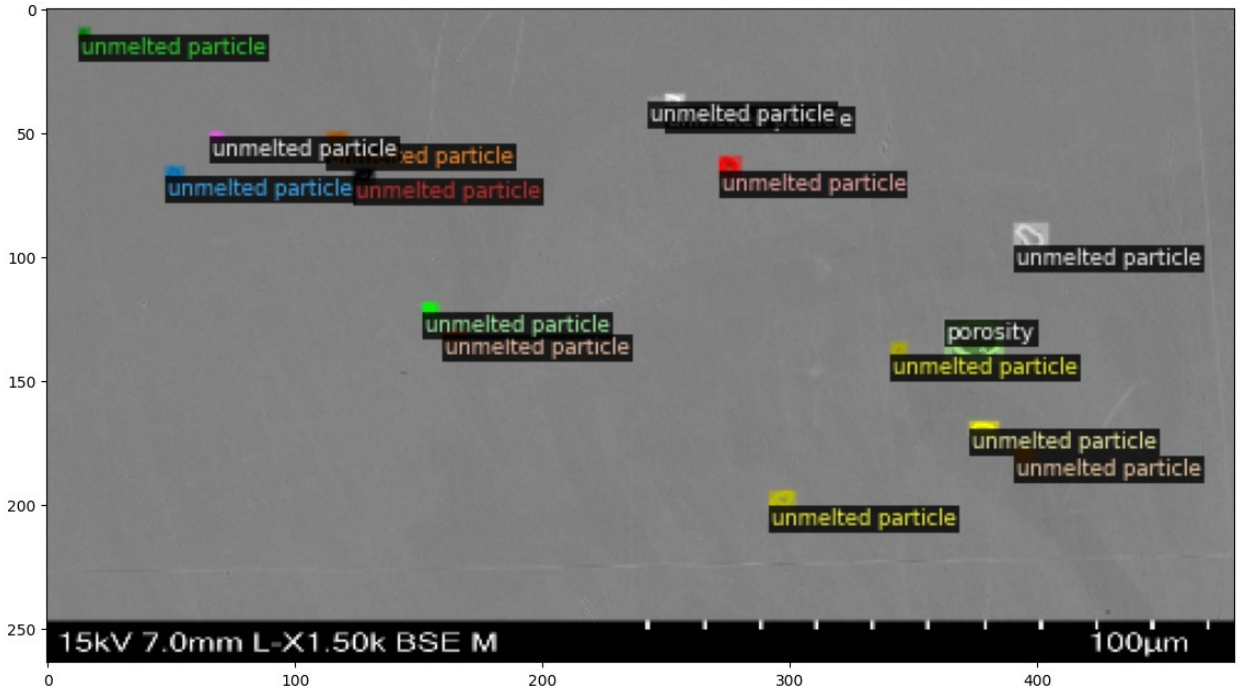
from detectron2.data import DatasetCatalog, MetadataCatalog
for d in ["train", "test"]:
    DatasetCatalog.register("p_" + d, lambda d=d:
get_r_dicts('/content/drive/MyDrive/Mahabub/' + d))
    MetadataCatalog.get("p_" + d).set(thing_classes=['unmelted
particle', 'porosity', 'microcrack'])
r_metadata = MetadataCatalog.get("p_train")

import random

dataset_dicts = get_r_dicts("/content/drive/MyDrive/Mahabub/train")
for d in random.sample(dataset_dicts, 3):
    img = cv2.imread(d["file_name"])
    v = Visualizer(img[:, :, ::-1], metadata=r_metadata, scale=0.5)
    v = v.draw_dataset_dict(d)
    plt.figure(figsize = (14, 10))
    plt.imshow(cv2.cvtColor(v.get_image()[:, :, ::-1],
cv2.COLOR_BGR2RGB))
    plt.show()
```


unmelted particle
unmelted particle
unmelted particle
porosity
unmelted particl
unmelted particle
unmelted particle
unmelted particle
unmelted particle
15kV 7.0mm L-X1.50k BSE M
100µm


unmelted particle
porosity
unmelted particle
unmelted particle
unmelted particle
unmelted particle
unmelted particle
unmelted particle
15kV 7.0mm L-X1.50k BSE H
100µm




```
from detectron2.engine import DefaultTrainer
from detectron2.config import get_cfg

cfg = get_cfg()
cfg.merge_from_file(model_zoo.get_config_file("COCO-
InstanceSegmentation/mask_rcnn_R_50_FPN_3x.yaml"))
cfg.DATASETS.TRAIN = ("p_train",)
cfg.DATASETS.TEST = ()
cfg.DATALOADER.NUM_WORKERS = 2
cfg.MODEL.WEIGHTS = model_zoo.get_checkpoint_url("COCO-
InstanceSegmentation/mask_rcnn_R_50_FPN_3x.yaml")
cfg.SOLVER.IMS_PER_BATCH = 2
cfg.SOLVER.BASE_LR = 0.00025
cfg.SOLVER.MAX_ITER = 2000
cfg.SOLVER.STEPS = []        # do not decay learning rate
cfg.MODEL.ROI_HEADS.NUM_CLASSES = 3

os.makedirs(cfg.OUTPUT_DIR, exist_ok=True)
trainer = DefaultTrainer(cfg)
trainer.resume_or_load(resume=False)
trainer.train()
```

```
[08/02 21:25:13 d2.engine.defaults]: Model:
GeneralizedRCNN(
  (backbone): FPN(
    (fpn_lateral2): Conv2d(256, 256, kernel_size=(1, 1), stride=(1,
1))
    (fpn_output2): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1),
```

```
padding=(1, 1))
    (fpn_lateral3): Conv2d(512, 256, kernel_size=(1, 1), stride=(1,
1))
    (fpn_output3): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1))
    (fpn_lateral4): Conv2d(1024, 256, kernel_size=(1, 1), stride=(1,
1))
    (fpn_output4): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1))
    (fpn_lateral5): Conv2d(2048, 256, kernel_size=(1, 1), stride=(1,
1))
    (fpn_output5): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1))
    (top_block): LastLevelMaxPool()
    (bottom_up): ResNet(
      (stem): BasicStem(
        (conv1): Conv2d(
          3, 64, kernel_size=(7, 7), stride=(2, 2), padding=(3, 3),
bias=False
          (norm): FrozenBatchNorm2d(num_features=64, eps=1e-05)
        )
      )
      (res2): Sequential(
        (0): BottleneckBlock(
          (shortcut): Conv2d(
            64, 256, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
          (conv1): Conv2d(
            64, 64, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=64, eps=1e-05)
          )
          (conv2): Conv2d(
            64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1),
bias=False
            (norm): FrozenBatchNorm2d(num_features=64, eps=1e-05)
          )
          (conv3): Conv2d(
            64, 256, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
        )
        (1): BottleneckBlock(
          (conv1): Conv2d(
            256, 64, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=64, eps=1e-05)
          )
          (conv2): Conv2d(
            64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1),
```

```
bias=False
            (norm): FrozenBatchNorm2d(num_features=64, eps=1e-05)
          )
          (conv3): Conv2d(
            64, 256, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
        )
        (2): BottleneckBlock(
          (conv1): Conv2d(
            256, 64, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=64, eps=1e-05)
          )
          (conv2): Conv2d(
            64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1),
bias=False
            (norm): FrozenBatchNorm2d(num_features=64, eps=1e-05)
          )
          (conv3): Conv2d(
            64, 256, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
        )
      )
      (res3): Sequential(
        (0): BottleneckBlock(
          (shortcut): Conv2d(
            256, 512, kernel_size=(1, 1), stride=(2, 2), bias=False
            (norm): FrozenBatchNorm2d(num_features=512, eps=1e-05)
          )
          (conv1): Conv2d(
            256, 128, kernel_size=(1, 1), stride=(2, 2), bias=False
            (norm): FrozenBatchNorm2d(num_features=128, eps=1e-05)
          )
          (conv2): Conv2d(
            128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), bias=False
            (norm): FrozenBatchNorm2d(num_features=128, eps=1e-05)
          )
          (conv3): Conv2d(
            128, 512, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=512, eps=1e-05)
          )
        )
        (1): BottleneckBlock(
          (conv1): Conv2d(
            512, 128, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=128, eps=1e-05)
          )
```

```
          (conv2): Conv2d(
            128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), bias=False
            (norm): FrozenBatchNorm2d(num_features=128, eps=1e-05)
          )
          (conv3): Conv2d(
            128, 512, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=512, eps=1e-05)
          )
        )
        (2): BottleneckBlock(
          (conv1): Conv2d(
            512, 128, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=128, eps=1e-05)
          )
          (conv2): Conv2d(
            128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), bias=False
            (norm): FrozenBatchNorm2d(num_features=128, eps=1e-05)
          )
          (conv3): Conv2d(
            128, 512, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=512, eps=1e-05)
          )
        )
        (3): BottleneckBlock(
          (conv1): Conv2d(
            512, 128, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=128, eps=1e-05)
          )
          (conv2): Conv2d(
            128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), bias=False
            (norm): FrozenBatchNorm2d(num_features=128, eps=1e-05)
          )
          (conv3): Conv2d(
            128, 512, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=512, eps=1e-05)
          )
        )
      )
      (res4): Sequential(
        (0): BottleneckBlock(
          (shortcut): Conv2d(
            512, 1024, kernel_size=(1, 1), stride=(2, 2), bias=False
            (norm): FrozenBatchNorm2d(num_features=1024, eps=1e-05)
          )
          (conv1): Conv2d(
            512, 256, kernel_size=(1, 1), stride=(2, 2), bias=False
```

```
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
          (conv2): Conv2d(
            256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
          (conv3): Conv2d(
            256, 1024, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=1024, eps=1e-05)
          )
        )
        (1): BottleneckBlock(
          (conv1): Conv2d(
            1024, 256, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
          (conv2): Conv2d(
            256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
          (conv3): Conv2d(
            256, 1024, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=1024, eps=1e-05)
          )
        )
        (2): BottleneckBlock(
          (conv1): Conv2d(
            1024, 256, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
          (conv2): Conv2d(
            256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
          (conv3): Conv2d(
            256, 1024, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=1024, eps=1e-05)
          )
        )
        (3): BottleneckBlock(
          (conv1): Conv2d(
            1024, 256, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
          (conv2): Conv2d(
            256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1,
```

```
1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
          (conv3): Conv2d(
            256, 1024, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=1024, eps=1e-05)
          )
        )
        (4): BottleneckBlock(
          (conv1): Conv2d(
            1024, 256, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
          (conv2): Conv2d(
            256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
          (conv3): Conv2d(
            256, 1024, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=1024, eps=1e-05)
          )
        )
        (5): BottleneckBlock(
          (conv1): Conv2d(
            1024, 256, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
          (conv2): Conv2d(
            256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
          (conv3): Conv2d(
            256, 1024, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=1024, eps=1e-05)
          )
        )
      )
      (res5): Sequential(
        (0): BottleneckBlock(
          (shortcut): Conv2d(
            1024, 2048, kernel_size=(1, 1), stride=(2, 2), bias=False
            (norm): FrozenBatchNorm2d(num_features=2048, eps=1e-05)
          )
          (conv1): Conv2d(
            1024, 512, kernel_size=(1, 1), stride=(2, 2), bias=False
            (norm): FrozenBatchNorm2d(num_features=512, eps=1e-05)
          )
```

```
          (conv2): Conv2d(
            512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), bias=False
            (norm): FrozenBatchNorm2d(num_features=512, eps=1e-05)
          )
          (conv3): Conv2d(
            512, 2048, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=2048, eps=1e-05)
          )
        )
        (1): BottleneckBlock(
          (conv1): Conv2d(
            2048, 512, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=512, eps=1e-05)
          )
          (conv2): Conv2d(
            512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), bias=False
            (norm): FrozenBatchNorm2d(num_features=512, eps=1e-05)
          )
          (conv3): Conv2d(
            512, 2048, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=2048, eps=1e-05)
          )
        )
        (2): BottleneckBlock(
          (conv1): Conv2d(
            2048, 512, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=512, eps=1e-05)
          )
          (conv2): Conv2d(
            512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), bias=False
            (norm): FrozenBatchNorm2d(num_features=512, eps=1e-05)
          )
          (conv3): Conv2d(
            512, 2048, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=2048, eps=1e-05)
          )
        )
      )
    )
  )
  (proposal_generator): RPN(
    (rpn_head): StandardRPNHead(
      (conv): Conv2d(
        256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1)
        (activation): ReLU()
      )
```

```
      (objectness_logits): Conv2d(256, 3, kernel_size=(1, 1),
stride=(1, 1))
      (anchor_deltas): Conv2d(256, 12, kernel_size=(1, 1), stride=(1,
1))
    )
    (anchor_generator): DefaultAnchorGenerator(
      (cell_anchors): BufferList()
    )
  )
  (roi_heads): StandardROIHeads(
    (box_pooler): ROIPooler(
      (level_poolers): ModuleList(
        (0): ROIAlign(output_size=(7, 7), spatial_scale=0.25,
sampling_ratio=0, aligned=True)
        (1): ROIAlign(output_size=(7, 7), spatial_scale=0.125,
sampling_ratio=0, aligned=True)
        (2): ROIAlign(output_size=(7, 7), spatial_scale=0.0625,
sampling_ratio=0, aligned=True)
        (3): ROIAlign(output_size=(7, 7), spatial_scale=0.03125,
sampling_ratio=0, aligned=True)
      )
    )
    (box_head): FastRCNNConvFCHead(
      (flatten): Flatten(start_dim=1, end_dim=-1)
      (fc1): Linear(in_features=12544, out_features=1024, bias=True)
      (fc_relu1): ReLU()
      (fc2): Linear(in_features=1024, out_features=1024, bias=True)
      (fc_relu2): ReLU()
    )
    (box_predictor): FastRCNNOutputLayers(
      (cls_score): Linear(in_features=1024, out_features=4, bias=True)
      (bbox_pred): Linear(in_features=1024, out_features=12,
bias=True)
    )
    (mask_pooler): ROIPooler(
      (level_poolers): ModuleList(
        (0): ROIAlign(output_size=(14, 14), spatial_scale=0.25,
sampling_ratio=0, aligned=True)
        (1): ROIAlign(output_size=(14, 14), spatial_scale=0.125,
sampling_ratio=0, aligned=True)
        (2): ROIAlign(output_size=(14, 14), spatial_scale=0.0625,
sampling_ratio=0, aligned=True)
        (3): ROIAlign(output_size=(14, 14), spatial_scale=0.03125,
sampling_ratio=0, aligned=True)
      )
    )
    (mask_head): MaskRCNNConvUpsampleHead(
      (mask_fcn1): Conv2d(
        256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1)
```

```
        (activation): ReLU()
      )
      (mask_fcn2): Conv2d(
        256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1)
        (activation): ReLU()
      )
      (mask_fcn3): Conv2d(
        256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1)
        (activation): ReLU()
      )
      (mask_fcn4): Conv2d(
        256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1)
        (activation): ReLU()
      )
      (deconv): ConvTranspose2d(256, 256, kernel_size=(2, 2),
stride=(2, 2))
      (deconv_relu): ReLU()
      (predictor): Conv2d(256, 3, kernel_size=(1, 1), stride=(1, 1))
    )
  )
)
[08/02 21:25:14 d2.data.build]: Removed 0 images with no usable
annotations. 42 images left.
[08/02 21:25:14 d2.data.build]: Distribution of instances among all 3
categories:
|   category    | #instances   |  category  | #instances   |  category
| #instances   |
|:-------------:|:-------------|:----------:|:-------------|:---------
-:|:-------------|
| unmelted pa.. | 639          |  porosity  | 67           |
microcrack | 9            |
|               |              |            |              |
|              |
|     total     | 715          |            |              |
|               |
[08/02 21:25:14 d2.data.dataset_mapper]: [DatasetMapper] Augmentations
used in training: [ResizeShortestEdge(short_edge_length=(640, 672,
704, 736, 768, 800), max_size=1333, sample_style='choice'),
RandomFlip()]
[08/02 21:25:14 d2.data.build]: Using training sampler TrainingSampler
[08/02 21:25:14 d2.data.common]: Serializing the dataset using: <class
'detectron2.data.common._TorchSerializedList'>
[08/02 21:25:14 d2.data.common]: Serializing 42 elements to byte
tensors and concatenating them all ...
[08/02 21:25:14 d2.data.common]: Serialized dataset takes 0.16 MiB
[08/02 21:25:14 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
```

```
model_final_f10217.pkl: 178MB [00:01, 163MB/s]

WARNING:fvcore.common.checkpoint:Skip loading parameter
'roi_heads.box_predictor.cls_score.weight' to the model due to
incompatible shapes: (81, 1024) in the checkpoint but (4, 1024) in the
model! You might want to double check if this is expected.
WARNING:fvcore.common.checkpoint:Skip loading parameter
'roi_heads.box_predictor.cls_score.bias' to the model due to
incompatible shapes: (81,) in the checkpoint but (4,) in the model!
You might want to double check if this is expected.
WARNING:fvcore.common.checkpoint:Skip loading parameter
'roi_heads.box_predictor.bbox_pred.weight' to the model due to
incompatible shapes: (320, 1024) in the checkpoint but (12, 1024) in
the model! You might want to double check if this is expected.
WARNING:fvcore.common.checkpoint:Skip loading parameter
'roi_heads.box_predictor.bbox_pred.bias' to the model due to
incompatible shapes: (320,) in the checkpoint but (12,) in the model!
You might want to double check if this is expected.
WARNING:fvcore.common.checkpoint:Skip loading parameter
'roi_heads.mask_head.predictor.weight' to the model due to
incompatible shapes: (80, 256, 1, 1) in the checkpoint but (3, 256, 1,
1) in the model! You might want to double check if this is expected.
WARNING:fvcore.common.checkpoint:Skip loading parameter
'roi_heads.mask_head.predictor.bias' to the model due to incompatible
shapes: (80,) in the checkpoint but (3,) in the model! You might want
to double check if this is expected.
WARNING:fvcore.common.checkpoint:Some model parameters or buffers are
not found in the checkpoint:
roi_heads.box_predictor.bbox_pred.{bias, weight}
roi_heads.box_predictor.cls_score.{bias, weight}
roi_heads.mask_head.predictor.{bias, weight}

[08/02 21:25:15 d2.engine.train_loop]: Starting training from
iteration 0

/usr/local/lib/python3.10/dist-packages/torch/functional.py:504:
UserWarning: torch.meshgrid: in an upcoming release, it will be
required to pass the indexing argument. (Triggered internally at
../aten/src/ATen/native/TensorShape.cpp:3483.)
  return _VF.meshgrid(tensors, **kwargs)  # type: ignore[attr-defined]

[08/02 21:25:26 d2.utils.events]:  eta: 0:11:18  iter: 19  total_loss:
4.283  loss_cls: 1.408  loss_box_reg: 0.658  loss_mask: 0.6902
loss_rpn_cls: 1.309  loss_rpn_loc: 0.246    time: 0.3621  last_time:
0.2262  data_time: 0.1078  last_data_time: 0.0089   lr: 4.9953e-06
max_mem: 2541M
[08/02 21:25:35 d2.utils.events]:  eta: 0:08:47  iter: 39  total_loss:
3.173  loss_cls: 1.266  loss_box_reg: 0.7197  loss_mask: 0.6858
loss_rpn_cls: 0.2506  loss_rpn_loc: 0.2274    time: 0.3087  last_time:
0.3227  data_time: 0.0085  last_data_time: 0.0063   lr: 9.9902e-06
```

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max_mem: 2555M
[08/02 21:25:41 d2.utils.events]:  eta: 0:09:32  iter: 59  total_loss:
2.716  loss_cls: 1.048  loss_box_reg: 0.6928  loss_mask: 0.6749
loss_rpn_cls: 0.07239  loss_rpn_loc: 0.2156    time: 0.3106
last_time: 0.2619  data_time: 0.0132  last_data_time: 0.0063   lr:
1.4985e-05  max_mem: 2555M
[08/02 21:25:46 d2.utils.events]:  eta: 0:08:33  iter: 79  total_loss:
2.382  loss_cls: 0.8217  loss_box_reg: 0.6606  loss_mask: 0.6619
loss_rpn_cls: 0.05443  loss_rpn_loc: 0.2135    time: 0.2972
last_time: 0.2602  data_time: 0.0097  last_data_time: 0.0057   lr:
1.998e-05  max_mem: 2555M
[08/02 21:25:54 d2.utils.events]:  eta: 0:08:32  iter: 99  total_loss:
2.19  loss_cls: 0.6479  loss_box_reg: 0.6445  loss_mask: 0.6446
loss_rpn_cls: 0.02951  loss_rpn_loc: 0.2098    time: 0.3201
last_time: 0.2608  data_time: 0.0212  last_data_time: 0.0145   lr:
2.4975e-05  max_mem: 2555M
[08/02 21:25:59 d2.utils.events]:  eta: 0:08:16  iter: 119
total_loss: 2.032  loss_cls: 0.5332  loss_box_reg: 0.6213  loss_mask:
0.6216  loss_rpn_cls: 0.05029  loss_rpn_loc: 0.2183    time: 0.3089
last_time: 0.2465  data_time: 0.0092  last_data_time: 0.0077   lr:
2.997e-05  max_mem: 2555M
[08/02 21:26:05 d2.utils.events]:  eta: 0:08:06  iter: 139
total_loss: 1.925  loss_cls: 0.4582  loss_box_reg: 0.6013  loss_mask:
0.5962  loss_rpn_cls: 0.04018  loss_rpn_loc: 0.2122    time: 0.3008
last_time: 0.3368  data_time: 0.0081  last_data_time: 0.0063   lr:
3.4965e-05  max_mem: 2555M
[08/02 21:26:11 d2.utils.events]:  eta: 0:08:03  iter: 159
total_loss: 1.863  loss_cls: 0.4368  loss_box_reg: 0.613  loss_mask:
0.5716  loss_rpn_cls: 0.04324  loss_rpn_loc: 0.2134    time: 0.3030
last_time: 0.2348  data_time: 0.0183  last_data_time: 0.0081   lr:
3.996e-05  max_mem: 2555M
[08/02 21:26:16 d2.utils.events]:  eta: 0:07:56  iter: 179
total_loss: 1.804  loss_cls: 0.3975  loss_box_reg: 0.6246  loss_mask:
0.5421  loss_rpn_cls: 0.03355  loss_rpn_loc: 0.2024    time: 0.2979
last_time: 0.2511  data_time: 0.0082  last_data_time: 0.0077   lr:
4.4955e-05  max_mem: 2555M
[08/02 21:26:22 d2.utils.events]:  eta: 0:07:52  iter: 199
total_loss: 1.735  loss_cls: 0.3594  loss_box_reg: 0.5922  loss_mask:
0.5166  loss_rpn_cls: 0.03512  loss_rpn_loc: 0.2033    time: 0.2975
last_time: 0.3597  data_time: 0.0115  last_data_time: 0.0062   lr:
4.995e-05  max_mem: 2555M
[08/02 21:26:28 d2.utils.events]:  eta: 0:07:46  iter: 219
total_loss: 1.647  loss_cls: 0.3396  loss_box_reg: 0.5747  loss_mask:
0.4865  loss_rpn_cls: 0.03764  loss_rpn_loc: 0.205    time: 0.2954
last_time: 0.2201  data_time: 0.0085  last_data_time: 0.0060   lr:
5.4945e-05  max_mem: 2555M
[08/02 21:26:33 d2.utils.events]:  eta: 0:07:40  iter: 239
total_loss: 1.644  loss_cls: 0.3177  loss_box_reg: 0.6001  loss_mask:
0.4795  loss_rpn_cls: 0.03374  loss_rpn_loc: 0.2187    time: 0.2919
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last_time: 0.2437  data_time: 0.0089  last_data_time: 0.0076   lr:
5.994e-05  max_mem: 2555M
[08/02 21:26:39 d2.utils.events]:  eta: 0:07:37  iter: 259
total_loss: 1.588  loss_cls: 0.3005  loss_box_reg: 0.5524  loss_mask:
0.4646  loss_rpn_cls: 0.03915  loss_rpn_loc: 0.2102    time: 0.2951
last_time: 0.2420  data_time: 0.0135  last_data_time: 0.0095   lr:
6.4935e-05  max_mem: 2555M
[08/02 21:26:44 d2.utils.events]:  eta: 0:07:30  iter: 279
total_loss: 1.63  loss_cls: 0.2996  loss_box_reg: 0.6321  loss_mask:
0.4388  loss_rpn_cls: 0.03308  loss_rpn_loc: 0.2038    time: 0.2923
last_time: 0.2714  data_time: 0.0090  last_data_time: 0.0072   lr:
6.993e-05  max_mem: 2555M
[08/02 21:26:50 d2.utils.events]:  eta: 0:07:25  iter: 299
total_loss: 1.484  loss_cls: 0.2784  loss_box_reg: 0.5488  loss_mask:
0.4267  loss_rpn_cls: 0.0296  loss_rpn_loc: 0.1998    time: 0.2904
last_time: 0.3152  data_time: 0.0077  last_data_time: 0.0065   lr:
7.4925e-05  max_mem: 2555M
[08/02 21:26:56 d2.utils.events]:  eta: 0:07:20  iter: 319
total_loss: 1.478  loss_cls: 0.2723  loss_box_reg: 0.5646  loss_mask:
0.4168  loss_rpn_cls: 0.03146  loss_rpn_loc: 0.2086    time: 0.2915
last_time: 0.2535  data_time: 0.0162  last_data_time: 0.0063   lr:
7.992e-05  max_mem: 2555M
[08/02 21:27:01 d2.utils.events]:  eta: 0:07:14  iter: 339
total_loss: 1.442  loss_cls: 0.2515  loss_box_reg: 0.5661  loss_mask:
0.3954  loss_rpn_cls: 0.03006  loss_rpn_loc: 0.1988    time: 0.2895
last_time: 0.2547  data_time: 0.0081  last_data_time: 0.0084   lr:
8.4915e-05  max_mem: 2555M
[08/02 21:27:07 d2.utils.events]:  eta: 0:07:09  iter: 359
total_loss: 1.444  loss_cls: 0.2557  loss_box_reg: 0.5891  loss_mask:
0.401  loss_rpn_cls: 0.03539  loss_rpn_loc: 0.2046    time: 0.2895
last_time: 0.2953  data_time: 0.0140  last_data_time: 0.0064   lr:
8.991e-05  max_mem: 2555M
[08/02 21:27:12 d2.utils.events]:  eta: 0:07:04  iter: 379
total_loss: 1.412  loss_cls: 0.2406  loss_box_reg: 0.5508  loss_mask:
0.3751  loss_rpn_cls: 0.03653  loss_rpn_loc: 0.2183    time: 0.2888
last_time: 0.2638  data_time: 0.0122  last_data_time: 0.0066   lr:
9.4905e-05  max_mem: 2555M
[08/02 21:27:18 d2.utils.events]:  eta: 0:06:57  iter: 399
total_loss: 1.389  loss_cls: 0.2358  loss_box_reg: 0.5406  loss_mask:
0.3817  loss_rpn_cls: 0.03826  loss_rpn_loc: 0.2014    time: 0.2875
last_time: 0.2426  data_time: 0.0106  last_data_time: 0.0202   lr:
9.99e-05  max_mem: 2555M
[08/02 21:27:24 d2.utils.events]:  eta: 0:06:53  iter: 419
total_loss: 1.351  loss_cls: 0.2284  loss_box_reg: 0.5168  loss_mask:
0.3701  loss_rpn_cls: 0.02347  loss_rpn_loc: 0.2063    time: 0.2889
last_time: 0.3295  data_time: 0.0136  last_data_time: 0.0086   lr:
0.0001049  max_mem: 2555M
[08/02 21:27:29 d2.utils.events]:  eta: 0:06:48  iter: 439
total_loss: 1.367  loss_cls: 0.2417  loss_box_reg: 0.554  loss_mask:
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0.3593  loss_rpn_cls: 0.02894  loss_rpn_loc: 0.1991    time: 0.2876
last_time: 0.2605  data_time: 0.0110  last_data_time: 0.0094   lr:
0.00010989  max_mem: 2556M
[08/02 21:27:34 d2.utils.events]:  eta: 0:06:42  iter: 459
total_loss: 1.337  loss_cls: 0.2388  loss_box_reg: 0.5316  loss_mask:
0.3613  loss_rpn_cls: 0.0367  loss_rpn_loc: 0.1984    time: 0.2863
last_time: 0.2554  data_time: 0.0099  last_data_time: 0.0094   lr:
0.00011489  max_mem: 2556M
[08/02 21:27:41 d2.utils.events]:  eta: 0:06:37  iter: 479
total_loss: 1.346  loss_cls: 0.233  loss_box_reg: 0.5226  loss_mask:
0.3541  loss_rpn_cls: 0.03188  loss_rpn_loc: 0.1929    time: 0.2875
last_time: 0.2409  data_time: 0.0171  last_data_time: 0.0065   lr:
0.00011988  max_mem: 2556M
[08/02 21:27:46 d2.utils.events]:  eta: 0:06:32  iter: 499
total_loss: 1.345  loss_cls: 0.2278  loss_box_reg: 0.5177  loss_mask:
0.3607  loss_rpn_cls: 0.02632  loss_rpn_loc: 0.1949    time: 0.2863
last_time: 0.2543  data_time: 0.0105  last_data_time: 0.0171   lr:
0.00012488  max_mem: 2556M
[08/02 21:27:52 d2.utils.events]:  eta: 0:06:27  iter: 519
total_loss: 1.338  loss_cls: 0.2216  loss_box_reg: 0.5305  loss_mask:
0.3497  loss_rpn_cls: 0.02938  loss_rpn_loc: 0.2004    time: 0.2866
last_time: 0.3788  data_time: 0.0133  last_data_time: 0.0244   lr:
0.00012987  max_mem: 2556M
[08/02 21:27:58 d2.utils.events]:  eta: 0:06:22  iter: 539
total_loss: 1.319  loss_cls: 0.2169  loss_box_reg: 0.5254  loss_mask:
0.3469  loss_rpn_cls: 0.02557  loss_rpn_loc: 0.1984    time: 0.2867
last_time: 0.2572  data_time: 0.0137  last_data_time: 0.0087   lr:
0.00013487  max_mem: 2556M
[08/02 21:28:03 d2.utils.events]:  eta: 0:06:17  iter: 559
total_loss: 1.317  loss_cls: 0.2171  loss_box_reg: 0.5104  loss_mask:
0.3466  loss_rpn_cls: 0.03433  loss_rpn_loc: 0.1999    time: 0.2856
last_time: 0.2692  data_time: 0.0079  last_data_time: 0.0074   lr:
0.00013986  max_mem: 2556M
[08/02 21:28:09 d2.utils.events]:  eta: 0:06:12  iter: 579
total_loss: 1.315  loss_cls: 0.2089  loss_box_reg: 0.4959  loss_mask:
0.3624  loss_rpn_cls: 0.02302  loss_rpn_loc: 0.2036    time: 0.2869
last_time: 0.2725  data_time: 0.0150  last_data_time: 0.0070   lr:
0.00014486  max_mem: 2556M
[08/02 21:28:14 d2.utils.events]:  eta: 0:06:06  iter: 599
total_loss: 1.252  loss_cls: 0.2086  loss_box_reg: 0.5016  loss_mask:
0.3412  loss_rpn_cls: 0.0258  loss_rpn_loc: 0.1843    time: 0.2859
last_time: 0.2590  data_time: 0.0087  last_data_time: 0.0166   lr:
0.00014985  max_mem: 2556M
[08/02 21:28:20 d2.utils.events]:  eta: 0:06:01  iter: 619
total_loss: 1.274  loss_cls: 0.1995  loss_box_reg: 0.4855  loss_mask:
0.3578  loss_rpn_cls: 0.02772  loss_rpn_loc: 0.1974    time: 0.2851
last_time: 0.3362  data_time: 0.0103  last_data_time: 0.0075   lr:
0.00015485  max_mem: 2556M
[08/02 21:28:26 d2.utils.events]:  eta: 0:05:56  iter: 639
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total_loss: 1.31  loss_cls: 0.2169  loss_box_reg: 0.4841  loss_mask:
0.3476  loss_rpn_cls: 0.02764  loss_rpn_loc: 0.1989    time: 0.2859
last_time: 0.2634  data_time: 0.0179  last_data_time: 0.0074   lr:
0.00015984  max_mem: 2556M
[08/02 21:28:31 d2.utils.events]:  eta: 0:05:50  iter: 659
total_loss: 1.244  loss_cls: 0.205  loss_box_reg: 0.4855  loss_mask:
0.3477  loss_rpn_cls: 0.02233  loss_rpn_loc: 0.1966    time: 0.2849
last_time: 0.2498  data_time: 0.0100  last_data_time: 0.0096   lr:
0.00016484  max_mem: 2556M
[08/02 21:28:37 d2.utils.events]:  eta: 0:05:45  iter: 679
total_loss: 1.283  loss_cls: 0.213  loss_box_reg: 0.4986  loss_mask:
0.3451  loss_rpn_cls: 0.01983  loss_rpn_loc: 0.1907    time: 0.2852
last_time: 0.3263  data_time: 0.0129  last_data_time: 0.0226   lr:
0.00016983  max_mem: 2556M
[08/02 21:28:42 d2.utils.events]:  eta: 0:05:40  iter: 699
total_loss: 1.234  loss_cls: 0.1984  loss_box_reg: 0.48  loss_mask:
0.3376  loss_rpn_cls: 0.02426  loss_rpn_loc: 0.1897    time: 0.2850
last_time: 0.2651  data_time: 0.0122  last_data_time: 0.0103   lr:
0.00017483  max_mem: 2556M
[08/02 21:28:48 d2.utils.events]:  eta: 0:05:34  iter: 719
total_loss: 1.287  loss_cls: 0.2109  loss_box_reg: 0.4769  loss_mask:
0.3487  loss_rpn_cls: 0.02567  loss_rpn_loc: 0.1911    time: 0.2842
last_time: 0.2502  data_time: 0.0088  last_data_time: 0.0102   lr:
0.00017982  max_mem: 2556M
[08/02 21:28:54 d2.utils.events]:  eta: 0:05:30  iter: 739
total_loss: 1.269  loss_cls: 0.1949  loss_box_reg: 0.4796  loss_mask:
0.3469  loss_rpn_cls: 0.03091  loss_rpn_loc: 0.2006    time: 0.2851
last_time: 0.2642  data_time: 0.0171  last_data_time: 0.0140   lr:
0.00018482  max_mem: 2556M
[08/02 21:28:59 d2.utils.events]:  eta: 0:05:24  iter: 759
total_loss: 1.253  loss_cls: 0.2063  loss_box_reg: 0.4814  loss_mask:
0.3421  loss_rpn_cls: 0.02827  loss_rpn_loc: 0.2058    time: 0.2842
last_time: 0.2337  data_time: 0.0090  last_data_time: 0.0092   lr:
0.00018981  max_mem: 2556M
[08/02 21:29:04 d2.utils.events]:  eta: 0:05:19  iter: 779
total_loss: 1.248  loss_cls: 0.1926  loss_box_reg: 0.4771  loss_mask:
0.3512  loss_rpn_cls: 0.02466  loss_rpn_loc: 0.189    time: 0.2839
last_time: 0.3485  data_time: 0.0097  last_data_time: 0.0083   lr:
0.00019481  max_mem: 2556M
[08/02 21:29:11 d2.utils.events]:  eta: 0:05:14  iter: 799
total_loss: 1.231  loss_cls: 0.1941  loss_box_reg: 0.4699  loss_mask:
0.3432  loss_rpn_cls: 0.02524  loss_rpn_loc: 0.2053    time: 0.2846
last_time: 0.2588  data_time: 0.0154  last_data_time: 0.0078   lr:
0.0001998  max_mem: 2556M
[08/02 21:29:16 d2.utils.events]:  eta: 0:05:08  iter: 819
total_loss: 1.211  loss_cls: 0.1977  loss_box_reg: 0.4807  loss_mask:
0.3361  loss_rpn_cls: 0.02482  loss_rpn_loc: 0.1985    time: 0.2839
last_time: 0.2560  data_time: 0.0100  last_data_time: 0.0072   lr:
0.0002048  max_mem: 2556M
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[08/02 21:29:22 d2.utils.events]:  eta: 0:05:03  iter: 839
total_loss: 1.234  loss_cls: 0.1929  loss_box_reg: 0.4759  loss_mask:
0.3438  loss_rpn_cls: 0.02137  loss_rpn_loc: 0.1891    time: 0.2841
last_time: 0.3354  data_time: 0.0105  last_data_time: 0.0058   lr:
0.00020979  max_mem: 2556M
[08/02 21:29:27 d2.utils.events]:  eta: 0:04:58  iter: 859
total_loss: 1.22  loss_cls: 0.1832  loss_box_reg: 0.4767  loss_mask:
0.3442  loss_rpn_cls: 0.02416  loss_rpn_loc: 0.1797    time: 0.2840
last_time: 0.2627  data_time: 0.0105  last_data_time: 0.0067   lr:
0.00021479  max_mem: 2556M
[08/02 21:29:32 d2.utils.events]:  eta: 0:04:53  iter: 879
total_loss: 1.26  loss_cls: 0.1976  loss_box_reg: 0.4946  loss_mask:
0.3425  loss_rpn_cls: 0.01821  loss_rpn_loc: 0.2004    time: 0.2833
last_time: 0.2634  data_time: 0.0091  last_data_time: 0.0095   lr:
0.00021978  max_mem: 2556M
[08/02 21:29:39 d2.utils.events]:  eta: 0:04:48  iter: 899
total_loss: 1.216  loss_cls: 0.1907  loss_box_reg: 0.4531  loss_mask:
0.3359  loss_rpn_cls: 0.02023  loss_rpn_loc: 0.1867    time: 0.2840
last_time: 0.2489  data_time: 0.0191  last_data_time: 0.0077   lr:
0.00022478  max_mem: 2556M
[08/02 21:29:44 d2.utils.events]:  eta: 0:04:42  iter: 919
total_loss: 1.203  loss_cls: 0.1769  loss_box_reg: 0.4603  loss_mask:
0.3432  loss_rpn_cls: 0.02161  loss_rpn_loc: 0.1885    time: 0.2834
last_time: 0.2260  data_time: 0.0086  last_data_time: 0.0054   lr:
0.00022977  max_mem: 2556M
[08/02 21:29:49 d2.utils.events]:  eta: 0:04:37  iter: 939
total_loss: 1.24  loss_cls: 0.1915  loss_box_reg: 0.4713  loss_mask:
0.3403  loss_rpn_cls: 0.02566  loss_rpn_loc: 0.1768    time: 0.2828
last_time: 0.3274  data_time: 0.0092  last_data_time: 0.0060   lr:
0.00023477  max_mem: 2556M
[08/02 21:29:55 d2.utils.events]:  eta: 0:04:32  iter: 959
total_loss: 1.186  loss_cls: 0.1778  loss_box_reg: 0.4547  loss_mask:
0.3339  loss_rpn_cls: 0.02209  loss_rpn_loc: 0.1868    time: 0.2835
last_time: 0.2624  data_time: 0.0177  last_data_time: 0.0062   lr:
0.00023976  max_mem: 2556M
[08/02 21:30:01 d2.utils.events]:  eta: 0:04:26  iter: 979
total_loss: 1.186  loss_cls: 0.1773  loss_box_reg: 0.4688  loss_mask:
0.3419  loss_rpn_cls: 0.02079  loss_rpn_loc: 0.1797    time: 0.2831
last_time: 0.2520  data_time: 0.0100  last_data_time: 0.0152   lr:
0.00024476  max_mem: 2556M
[08/02 21:30:07 d2.utils.events]:  eta: 0:04:21  iter: 999
total_loss: 1.209  loss_cls: 0.1861  loss_box_reg: 0.4919  loss_mask:
0.3337  loss_rpn_cls: 0.02289  loss_rpn_loc: 0.1702    time: 0.2834
last_time: 0.3370  data_time: 0.0137  last_data_time: 0.0246   lr:
0.00024975  max_mem: 2557M
[08/02 21:30:12 d2.utils.events]:  eta: 0:04:16  iter: 1019
total_loss: 1.148  loss_cls: 0.1677  loss_box_reg: 0.4405  loss_mask:
0.3378  loss_rpn_cls: 0.02169  loss_rpn_loc: 0.1756    time: 0.2835
last_time: 0.3348  data_time: 0.0121  last_data_time: 0.0282   lr:
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0.00025  max_mem: 2557M
[08/02 21:30:19 d2.utils.events]:  eta: 0:04:11  iter: 1039
total_loss: 1.174  loss_cls: 0.1712  loss_box_reg: 0.4315  loss_mask:
0.3331  loss_rpn_cls: 0.02312  loss_rpn_loc: 0.1752    time: 0.2842
last_time: 0.3423  data_time: 0.0175  last_data_time: 0.0198   lr:
0.00025  max_mem: 2557M
[08/02 21:30:25 d2.utils.events]:  eta: 0:04:06  iter: 1059
total_loss: 1.16  loss_cls: 0.169  loss_box_reg: 0.4444  loss_mask:
0.343  loss_rpn_cls: 0.01591  loss_rpn_loc: 0.1693    time: 0.2847
last_time: 0.2620  data_time: 0.0144  last_data_time: 0.0059   lr:
0.00025  max_mem: 2557M
[08/02 21:30:30 d2.utils.events]:  eta: 0:04:01  iter: 1079
total_loss: 1.149  loss_cls: 0.169  loss_box_reg: 0.4444  loss_mask:
0.3368  loss_rpn_cls: 0.02155  loss_rpn_loc: 0.1806    time: 0.2842
last_time: 0.2618  data_time: 0.0081  last_data_time: 0.0068   lr:
0.00025  max_mem: 2557M
[08/02 21:30:36 d2.utils.events]:  eta: 0:03:55  iter: 1099
total_loss: 1.113  loss_cls: 0.1698  loss_box_reg: 0.4286  loss_mask:
0.3325  loss_rpn_cls: 0.02235  loss_rpn_loc: 0.1779    time: 0.2843
last_time: 0.3355  data_time: 0.0090  last_data_time: 0.0061   lr:
0.00025  max_mem: 2557M
[08/02 21:30:42 d2.utils.events]:  eta: 0:03:50  iter: 1119
total_loss: 1.153  loss_cls: 0.1799  loss_box_reg: 0.4414  loss_mask:
0.3305  loss_rpn_cls: 0.02937  loss_rpn_loc: 0.1885    time: 0.2843
last_time: 0.2489  data_time: 0.0095  last_data_time: 0.0112   lr:
0.00025  max_mem: 2557M
[08/02 21:30:47 d2.utils.events]:  eta: 0:03:45  iter: 1139
total_loss: 1.121  loss_cls: 0.1705  loss_box_reg: 0.4351  loss_mask:
0.3271  loss_rpn_cls: 0.02543  loss_rpn_loc: 0.1733    time: 0.2838
last_time: 0.2657  data_time: 0.0083  last_data_time: 0.0065   lr:
0.00025  max_mem: 2557M
[08/02 21:30:53 d2.utils.events]:  eta: 0:03:40  iter: 1159
total_loss: 1.168  loss_cls: 0.1698  loss_box_reg: 0.4391  loss_mask:
0.3269  loss_rpn_cls: 0.02161  loss_rpn_loc: 0.1827    time: 0.2844
last_time: 0.3156  data_time: 0.0124  last_data_time: 0.0067   lr:
0.00025  max_mem: 2557M
[08/02 21:30:58 d2.utils.events]:  eta: 0:03:35  iter: 1179
total_loss: 1.143  loss_cls: 0.1766  loss_box_reg: 0.4485  loss_mask:
0.3341  loss_rpn_cls: 0.02038  loss_rpn_loc: 0.1796    time: 0.2839
last_time: 0.2494  data_time: 0.0078  last_data_time: 0.0070   lr:
0.00025  max_mem: 2557M
[08/02 21:31:04 d2.utils.events]:  eta: 0:03:29  iter: 1199
total_loss: 1.131  loss_cls: 0.1606  loss_box_reg: 0.4339  loss_mask:
0.3308  loss_rpn_cls: 0.01826  loss_rpn_loc: 0.1776    time: 0.2835
last_time: 0.3505  data_time: 0.0089  last_data_time: 0.0068   lr:
0.00025  max_mem: 2557M
[08/02 21:31:10 d2.utils.events]:  eta: 0:03:24  iter: 1219
total_loss: 1.146  loss_cls: 0.1791  loss_box_reg: 0.437  loss_mask:
0.3382  loss_rpn_cls: 0.01822  loss_rpn_loc: 0.1726    time: 0.2841
```

```
last_time: 0.2326  data_time: 0.0158  last_data_time: 0.0182   lr:
0.00025  max_mem: 2557M
[08/02 21:31:15 d2.utils.events]:  eta: 0:03:19  iter: 1239
total_loss: 1.122  loss_cls: 0.1646  loss_box_reg: 0.4685  loss_mask:
0.3236  loss_rpn_cls: 0.02566  loss_rpn_loc: 0.1748    time: 0.2837
last_time: 0.2406  data_time: 0.0086  last_data_time: 0.0069   lr:
0.00025  max_mem: 2557M
[08/02 21:31:21 d2.utils.events]:  eta: 0:03:14  iter: 1259
total_loss: 1.111  loss_cls: 0.1678  loss_box_reg: 0.4313  loss_mask:
0.3231  loss_rpn_cls: 0.01942  loss_rpn_loc: 0.1681    time: 0.2838
last_time: 0.3480  data_time: 0.0115  last_data_time: 0.0255   lr:
0.00025  max_mem: 2557M
[08/02 21:31:27 d2.utils.events]:  eta: 0:03:09  iter: 1279
total_loss: 1.104  loss_cls: 0.1643  loss_box_reg: 0.4392  loss_mask:
0.3297  loss_rpn_cls: 0.01676  loss_rpn_loc: 0.1694    time: 0.2837
last_time: 0.2584  data_time: 0.0090  last_data_time: 0.0085   lr:
0.00025  max_mem: 2557M
[08/02 21:31:32 d2.utils.events]:  eta: 0:03:03  iter: 1299
total_loss: 1.118  loss_cls: 0.1651  loss_box_reg: 0.4429  loss_mask:
0.3306  loss_rpn_cls: 0.01574  loss_rpn_loc: 0.1692    time: 0.2833
last_time: 0.2608  data_time: 0.0090  last_data_time: 0.0069   lr:
0.00025  max_mem: 2557M
[08/02 21:31:38 d2.utils.events]:  eta: 0:02:58  iter: 1319
total_loss: 1.09  loss_cls: 0.1602  loss_box_reg: 0.4017  loss_mask:
0.3207  loss_rpn_cls: 0.01516  loss_rpn_loc: 0.1759    time: 0.2839
last_time: 0.2586  data_time: 0.0175  last_data_time: 0.0064   lr:
0.00025  max_mem: 2557M
[08/02 21:31:43 d2.utils.events]:  eta: 0:02:53  iter: 1339
total_loss: 1.078  loss_cls: 0.1655  loss_box_reg: 0.4152  loss_mask:
0.3271  loss_rpn_cls: 0.01585  loss_rpn_loc: 0.17    time: 0.2834
last_time: 0.2672  data_time: 0.0074  last_data_time: 0.0099   lr:
0.00025  max_mem: 2557M
[08/02 21:31:49 d2.utils.events]:  eta: 0:02:48  iter: 1359
total_loss: 1.167  loss_cls: 0.1692  loss_box_reg: 0.4068  loss_mask:
0.3242  loss_rpn_cls: 0.02025  loss_rpn_loc: 0.1699    time: 0.2832
last_time: 0.3735  data_time: 0.0083  last_data_time: 0.0083   lr:
0.00025  max_mem: 2557M
[08/02 21:31:55 d2.utils.events]:  eta: 0:02:42  iter: 1379
total_loss: 1.15  loss_cls: 0.1638  loss_box_reg: 0.4459  loss_mask:
0.3262  loss_rpn_cls: 0.01924  loss_rpn_loc: 0.1791    time: 0.2836
last_time: 0.2599  data_time: 0.0194  last_data_time: 0.0074   lr:
0.00025  max_mem: 2557M
[08/02 21:32:00 d2.utils.events]:  eta: 0:02:37  iter: 1399
total_loss: 1.102  loss_cls: 0.1523  loss_box_reg: 0.4181  loss_mask:
0.3328  loss_rpn_cls: 0.02126  loss_rpn_loc: 0.167    time: 0.2832
last_time: 0.2784  data_time: 0.0102  last_data_time: 0.0157   lr:
0.00025  max_mem: 2557M
[08/02 21:32:06 d2.utils.events]:  eta: 0:02:32  iter: 1419
total_loss: 1.105  loss_cls: 0.1633  loss_box_reg: 0.4426  loss_mask:
```

```
0.3306  loss_rpn_cls: 0.02573  loss_rpn_loc: 0.1645    time: 0.2835
last_time: 0.3683  data_time: 0.0164  last_data_time: 0.0066   lr:
0.00025  max_mem: 2557M
[08/02 21:32:12 d2.utils.events]:  eta: 0:02:27  iter: 1439
total_loss: 1.14  loss_cls: 0.1712  loss_box_reg: 0.431  loss_mask:
0.3317  loss_rpn_cls: 0.0192  loss_rpn_loc: 0.1678    time: 0.2834
last_time: 0.2549  data_time: 0.0130  last_data_time: 0.0063   lr:
0.00025  max_mem: 2557M
[08/02 21:32:17 d2.utils.events]:  eta: 0:02:21  iter: 1459
total_loss: 1.073  loss_cls: 0.1467  loss_box_reg: 0.419  loss_mask:
0.3187  loss_rpn_cls: 0.01791  loss_rpn_loc: 0.1698    time: 0.2830
last_time: 0.2556  data_time: 0.0100  last_data_time: 0.0062   lr:
0.00025  max_mem: 2557M
[08/02 21:32:23 d2.utils.events]:  eta: 0:02:16  iter: 1479
total_loss: 1.091  loss_cls: 0.1567  loss_box_reg: 0.4096  loss_mask:
0.3261  loss_rpn_cls: 0.01644  loss_rpn_loc: 0.1719    time: 0.2835
last_time: 0.2669  data_time: 0.0126  last_data_time: 0.0128   lr:
0.00025  max_mem: 2557M
[08/02 21:32:28 d2.utils.events]:  eta: 0:02:11  iter: 1499
total_loss: 1.1  loss_cls: 0.1531  loss_box_reg: 0.4257  loss_mask:
0.3284  loss_rpn_cls: 0.02294  loss_rpn_loc: 0.1677    time: 0.2831
last_time: 0.2592  data_time: 0.0081  last_data_time: 0.0076   lr:
0.00025  max_mem: 2557M
[08/02 21:32:34 d2.utils.events]:  eta: 0:02:05  iter: 1519
total_loss: 1.075  loss_cls: 0.1445  loss_box_reg: 0.4284  loss_mask:
0.326  loss_rpn_cls: 0.01528  loss_rpn_loc: 0.1583    time: 0.2829
last_time: 0.3667  data_time: 0.0096  last_data_time: 0.0274   lr:
0.00025  max_mem: 2557M
[08/02 21:32:40 d2.utils.events]:  eta: 0:02:00  iter: 1539
total_loss: 1.078  loss_cls: 0.1523  loss_box_reg: 0.429  loss_mask:
0.3263  loss_rpn_cls: 0.01491  loss_rpn_loc: 0.169    time: 0.2833
last_time: 0.2605  data_time: 0.0183  last_data_time: 0.0081   lr:
0.00025  max_mem: 2557M
[08/02 21:32:45 d2.utils.events]:  eta: 0:01:55  iter: 1559
total_loss: 1.116  loss_cls: 0.151  loss_box_reg: 0.4262  loss_mask:
0.3206  loss_rpn_cls: 0.02558  loss_rpn_loc: 0.1649    time: 0.2829
last_time: 0.2633  data_time: 0.0092  last_data_time: 0.0074   lr:
0.00025  max_mem: 2557M
[08/02 21:32:51 d2.utils.events]:  eta: 0:01:50  iter: 1579
total_loss: 1.068  loss_cls: 0.147  loss_box_reg: 0.4084  loss_mask:
0.3324  loss_rpn_cls: 0.01848  loss_rpn_loc: 0.1632    time: 0.2832
last_time: 0.3744  data_time: 0.0118  last_data_time: 0.0191   lr:
0.00025  max_mem: 2557M
[08/02 21:32:58 d2.utils.events]:  eta: 0:01:45  iter: 1599
total_loss: 1.094  loss_cls: 0.1472  loss_box_reg: 0.4297  loss_mask:
0.3317  loss_rpn_cls: 0.02107  loss_rpn_loc: 0.154    time: 0.2840
last_time: 0.2278  data_time: 0.0177  last_data_time: 0.0069   lr:
0.00025  max_mem: 2557M
[08/02 21:33:03 d2.utils.events]:  eta: 0:01:39  iter: 1619
```

```
total_loss: 1.082  loss_cls: 0.1495  loss_box_reg: 0.442  loss_mask:
0.3247  loss_rpn_cls: 0.02507  loss_rpn_loc: 0.166    time: 0.2837
last_time: 0.2740  data_time: 0.0086  last_data_time: 0.0079   lr:
0.00025  max_mem: 2557M
[08/02 21:33:10 d2.utils.events]:  eta: 0:01:34  iter: 1639
total_loss: 1.074  loss_cls: 0.1483  loss_box_reg: 0.4194  loss_mask:
0.3207  loss_rpn_cls: 0.02469  loss_rpn_loc: 0.1624    time: 0.2841
last_time: 0.2607  data_time: 0.0176  last_data_time: 0.0231   lr:
0.00025  max_mem: 2557M
[08/02 21:33:15 d2.utils.events]:  eta: 0:01:29  iter: 1659
total_loss: 1.028  loss_cls: 0.1451  loss_box_reg: 0.4029  loss_mask:
0.3224  loss_rpn_cls: 0.02161  loss_rpn_loc: 0.1652    time: 0.2839
last_time: 0.2677  data_time: 0.0108  last_data_time: 0.0089   lr:
0.00025  max_mem: 2557M
[08/02 21:33:21 d2.utils.events]:  eta: 0:01:24  iter: 1679
total_loss: 1.079  loss_cls: 0.1494  loss_box_reg: 0.4027  loss_mask:
0.3226  loss_rpn_cls: 0.01679  loss_rpn_loc: 0.1584    time: 0.2838
last_time: 0.3362  data_time: 0.0103  last_data_time: 0.0065   lr:
0.00025  max_mem: 2557M
[08/02 21:33:26 d2.utils.events]:  eta: 0:01:18  iter: 1699
total_loss: 1.058  loss_cls: 0.1473  loss_box_reg: 0.3975  loss_mask:
0.328  loss_rpn_cls: 0.01715  loss_rpn_loc: 0.1621    time: 0.2840
last_time: 0.2537  data_time: 0.0106  last_data_time: 0.0094   lr:
0.00025  max_mem: 2557M
[08/02 21:33:32 d2.utils.events]:  eta: 0:01:13  iter: 1719
total_loss: 1.081  loss_cls: 0.1474  loss_box_reg: 0.4289  loss_mask:
0.3298  loss_rpn_cls: 0.01654  loss_rpn_loc: 0.1622    time: 0.2837
last_time: 0.2571  data_time: 0.0092  last_data_time: 0.0117   lr:
0.00025  max_mem: 2557M
[08/02 21:33:38 d2.utils.events]:  eta: 0:01:08  iter: 1739
total_loss: 1.014  loss_cls: 0.1386  loss_box_reg: 0.3988  loss_mask:
0.3111  loss_rpn_cls: 0.01925  loss_rpn_loc: 0.1555    time: 0.2841
last_time: 0.3385  data_time: 0.0155  last_data_time: 0.0064   lr:
0.00025  max_mem: 2557M
[08/02 21:33:43 d2.utils.events]:  eta: 0:01:03  iter: 1759
total_loss: 1.062  loss_cls: 0.1365  loss_box_reg: 0.3956  loss_mask:
0.3193  loss_rpn_cls: 0.02021  loss_rpn_loc: 0.1482    time: 0.2838
last_time: 0.2528  data_time: 0.0088  last_data_time: 0.0064   lr:
0.00025  max_mem: 2557M
[08/02 21:33:49 d2.utils.events]:  eta: 0:00:57  iter: 1779
total_loss: 1.087  loss_cls: 0.1442  loss_box_reg: 0.4213  loss_mask:
0.3303  loss_rpn_cls: 0.01962  loss_rpn_loc: 0.1648    time: 0.2836
last_time: 0.3002  data_time: 0.0077  last_data_time: 0.0079   lr:
0.00025  max_mem: 2557M
[08/02 21:33:55 d2.utils.events]:  eta: 0:00:52  iter: 1799
total_loss: 1.036  loss_cls: 0.1376  loss_box_reg: 0.4051  loss_mask:
0.3108  loss_rpn_cls: 0.01616  loss_rpn_loc: 0.1535    time: 0.2840
last_time: 0.2637  data_time: 0.0181  last_data_time: 0.0073   lr:
0.00025  max_mem: 2557M
```

```
[08/02 21:34:00 d2.utils.events]:  eta: 0:00:47  iter: 1819
total_loss: 1.073  loss_cls: 0.1355  loss_box_reg: 0.4072  loss_mask:
0.3292  loss_rpn_cls: 0.01649  loss_rpn_loc: 0.1608    time: 0.2837
last_time: 0.2558  data_time: 0.0093  last_data_time: 0.0090   lr:
0.00025  max_mem: 2557M
[08/02 21:34:06 d2.utils.events]:  eta: 0:00:42  iter: 1839
total_loss: 1.082  loss_cls: 0.1466  loss_box_reg: 0.425  loss_mask:
0.3205  loss_rpn_cls: 0.02445  loss_rpn_loc: 0.1615    time: 0.2839
last_time: 0.3584  data_time: 0.0138  last_data_time: 0.0106   lr:
0.00025  max_mem: 2557M
[08/02 21:34:12 d2.utils.events]:  eta: 0:00:36  iter: 1859
total_loss: 1.045  loss_cls: 0.1399  loss_box_reg: 0.4236  loss_mask:
0.3208  loss_rpn_cls: 0.02013  loss_rpn_loc: 0.1521    time: 0.2839
last_time: 0.2401  data_time: 0.0120  last_data_time: 0.0070   lr:
0.00025  max_mem: 2557M
[08/02 21:34:17 d2.utils.events]:  eta: 0:00:31  iter: 1879
total_loss: 1.023  loss_cls: 0.1383  loss_box_reg: 0.382  loss_mask:
0.3161  loss_rpn_cls: 0.01554  loss_rpn_loc: 0.1492    time: 0.2836
last_time: 0.2612  data_time: 0.0118  last_data_time: 0.0076   lr:
0.00025  max_mem: 2557M
[08/02 21:34:23 d2.utils.events]:  eta: 0:00:26  iter: 1899
total_loss: 1.063  loss_cls: 0.138  loss_box_reg: 0.4003  loss_mask:
0.3173  loss_rpn_cls: 0.01586  loss_rpn_loc: 0.1628    time: 0.2840
last_time: 0.2435  data_time: 0.0122  last_data_time: 0.0068   lr:
0.00025  max_mem: 2557M
[08/02 21:34:29 d2.utils.events]:  eta: 0:00:21  iter: 1919
total_loss: 1.006  loss_cls: 0.1324  loss_box_reg: 0.3929  loss_mask:
0.3198  loss_rpn_cls: 0.01507  loss_rpn_loc: 0.1533    time: 0.2837
last_time: 0.2625  data_time: 0.0082  last_data_time: 0.0067   lr:
0.00025  max_mem: 2557M
[08/02 21:34:34 d2.utils.events]:  eta: 0:00:15  iter: 1939
total_loss: 1.039  loss_cls: 0.142  loss_box_reg: 0.4009  loss_mask:
0.3084  loss_rpn_cls: 0.01367  loss_rpn_loc: 0.1567    time: 0.2836
last_time: 0.3210  data_time: 0.0103  last_data_time: 0.0265   lr:
0.00025  max_mem: 2557M
[08/02 21:34:40 d2.utils.events]:  eta: 0:00:10  iter: 1959
total_loss: 1.012  loss_cls: 0.1378  loss_box_reg: 0.3965  loss_mask:
0.3266  loss_rpn_cls: 0.02368  loss_rpn_loc: 0.1435    time: 0.2838
last_time: 0.2615  data_time: 0.0130  last_data_time: 0.0089   lr:
0.00025  max_mem: 2557M
[08/02 21:34:45 d2.utils.events]:  eta: 0:00:05  iter: 1979
total_loss: 1.043  loss_cls: 0.1341  loss_box_reg: 0.4233  loss_mask:
0.3095  loss_rpn_cls: 0.02136  loss_rpn_loc: 0.1417    time: 0.2835
last_time: 0.2644  data_time: 0.0073  last_data_time: 0.0090   lr:
0.00025  max_mem: 2557M
[08/02 21:34:53 d2.utils.events]:  eta: 0:00:00  iter: 1999
total_loss: 1.003  loss_cls: 0.1309  loss_box_reg: 0.3887  loss_mask:
0.3057  loss_rpn_cls: 0.02356  loss_rpn_loc: 0.1523    time: 0.2837
last_time: 0.3869  data_time: 0.0164  last_data_time: 0.0269   lr:
0.00025  max_mem: 2557M
```

```
[08/02 21:34:53 d2.engine.hooks]: Overall training speed: 1998
iterations in 0:09:26 (0.2837 s / it)
[08/02 21:34:53 d2.engine.hooks]: Total training time: 0:09:33
(0:00:06 on hooks)
```

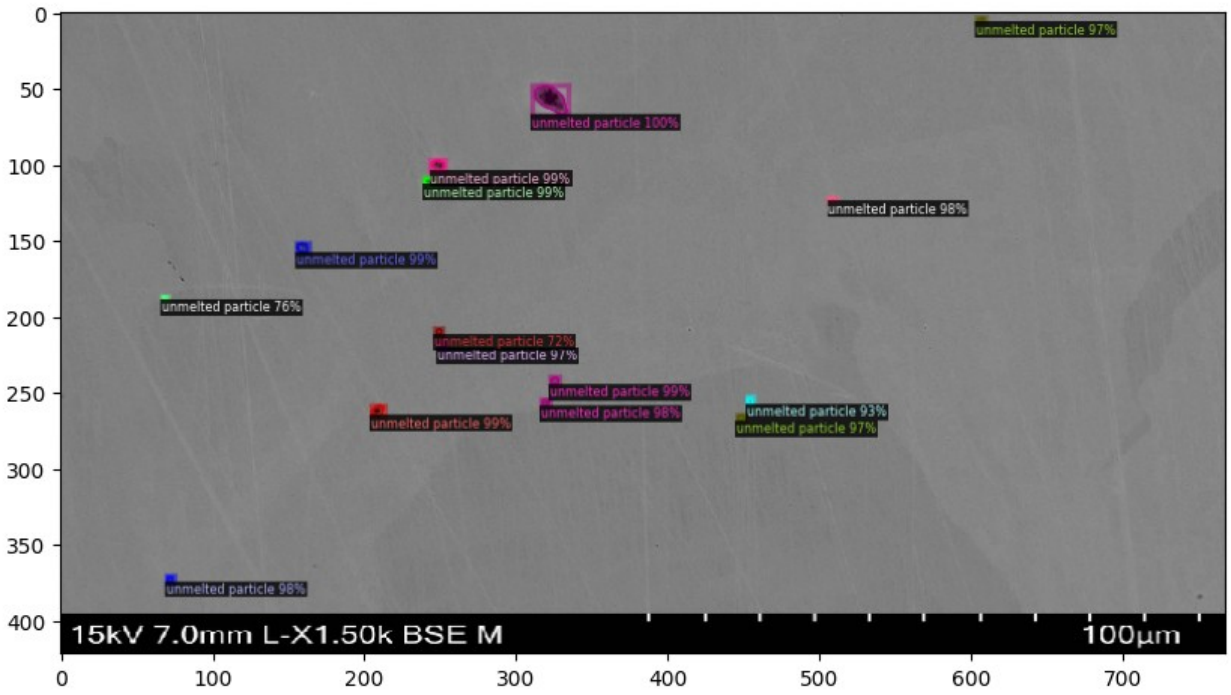
```
# Look at training curves in tensorboard:
%load_ext tensorboard
%tensorboard --logdir output
```

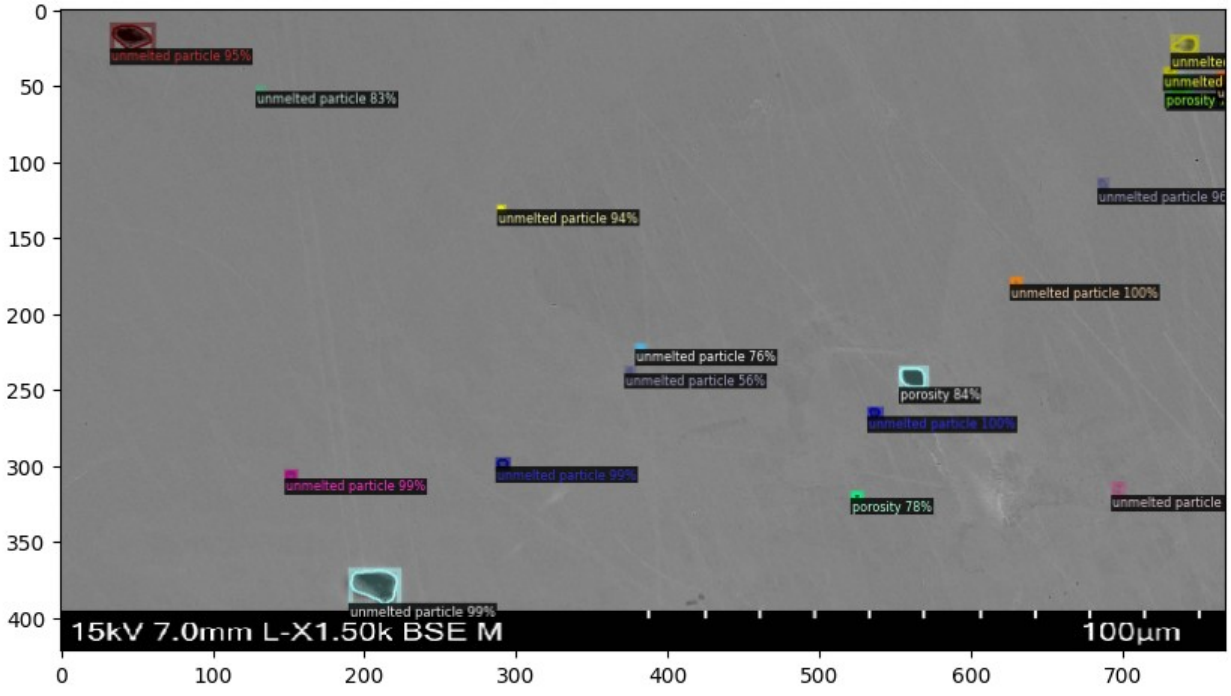
```
<IPython.core.display.Javascript object>
```

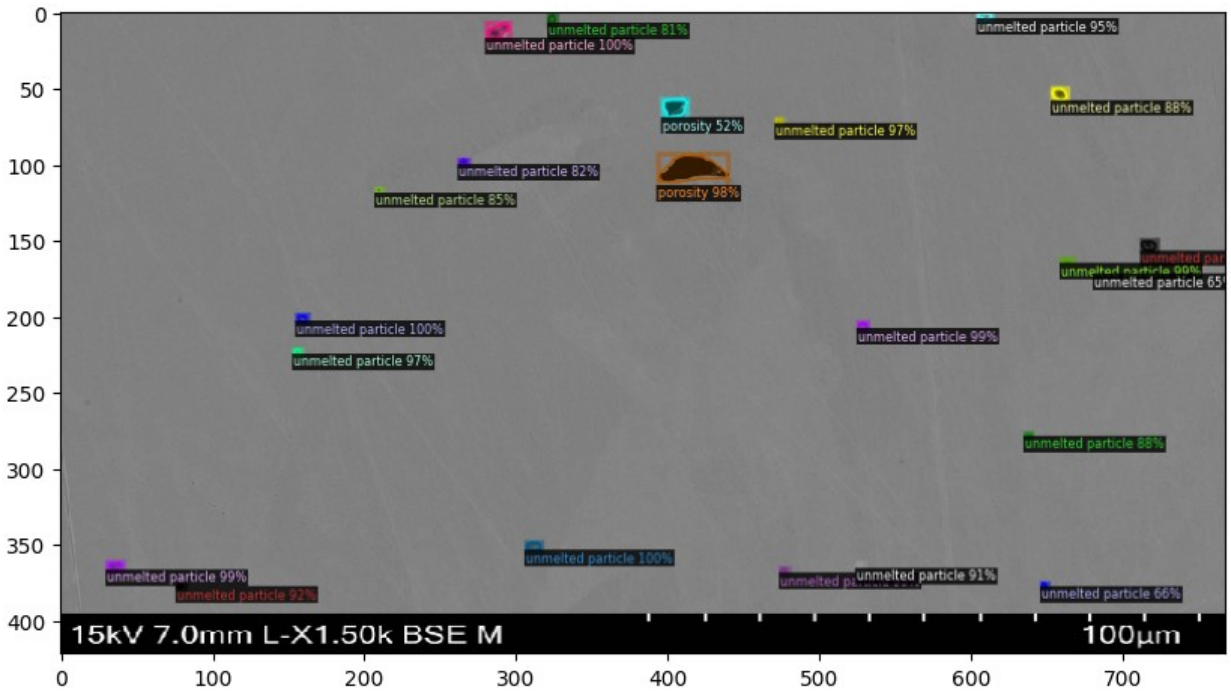
```
cfg.MODEL.WEIGHTS = os.path.join(cfg.OUTPUT_DIR, "model_final.pth")
cfg.MODEL.ROI_HEADS.SCORE_THRESH_TEST = 0.5
cfg.DATASETS.TEST = ("p_test", )
predictor = DefaultPredictor(cfg)
```

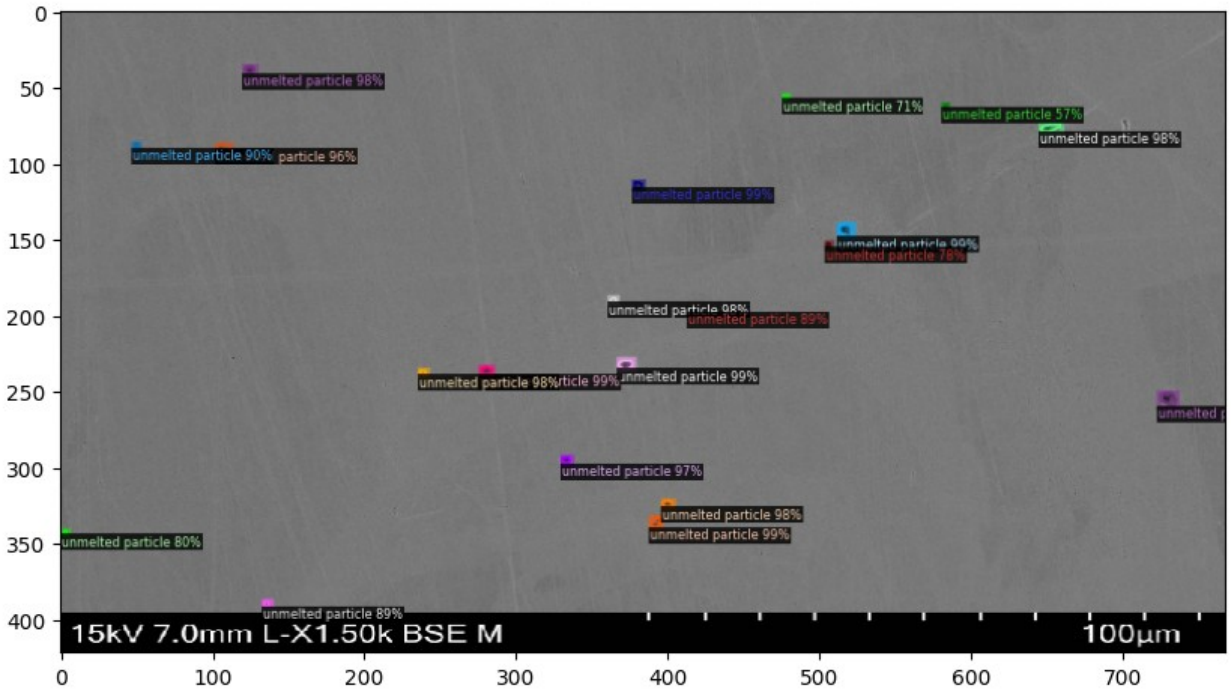
```
[08/02 21:35:48 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from ./output/model_final.pth ...
```

```
from detectron2.utils.visualizer import ColorMode
dataset_dicts = get_r_dicts('/content/drive/MyDrive/Mahabub/train')
for d in random.sample(dataset_dicts, 4):
    im = cv2.imread(d["file_name"])
    outputs = predictor(im)
    v = Visualizer(im[:, :, ::-1],
                   metadata=r_metadata,
                   scale=0.8,
                   instance_mode=ColorMode.IMAGE_BW   # remove the
colors of unsegmented pixels
    )
    v = v.draw_instance_predictions(outputs["instances"].to("cpu"))
    plt.figure(figsize = (10, 10))
    plt.imshow(cv2.cvtColor(v.get_image()[:, :, ::-1],
cv2.COLOR_BGR2RGB))
    plt.show()
```


unmelted particle 97%
unmelted particle 100%
unmelted particle 99%
unmelted particle 99%
unmelted particle 98%
unmelted particle 99%
unmelted particle 76%
unmelted particle 72%
unmelted particle 97%
unmelted particle 99%
unmelted particle 99%
unmelted particle 98%
unmelted particle 93%
unmelted particle 97%
unmelted particle 98%
15kV 7.0mm L-X1.50k BSE M
100µm
0
100
200
300
400
500
600
700
0
50
100
150
200
250
300
350
400

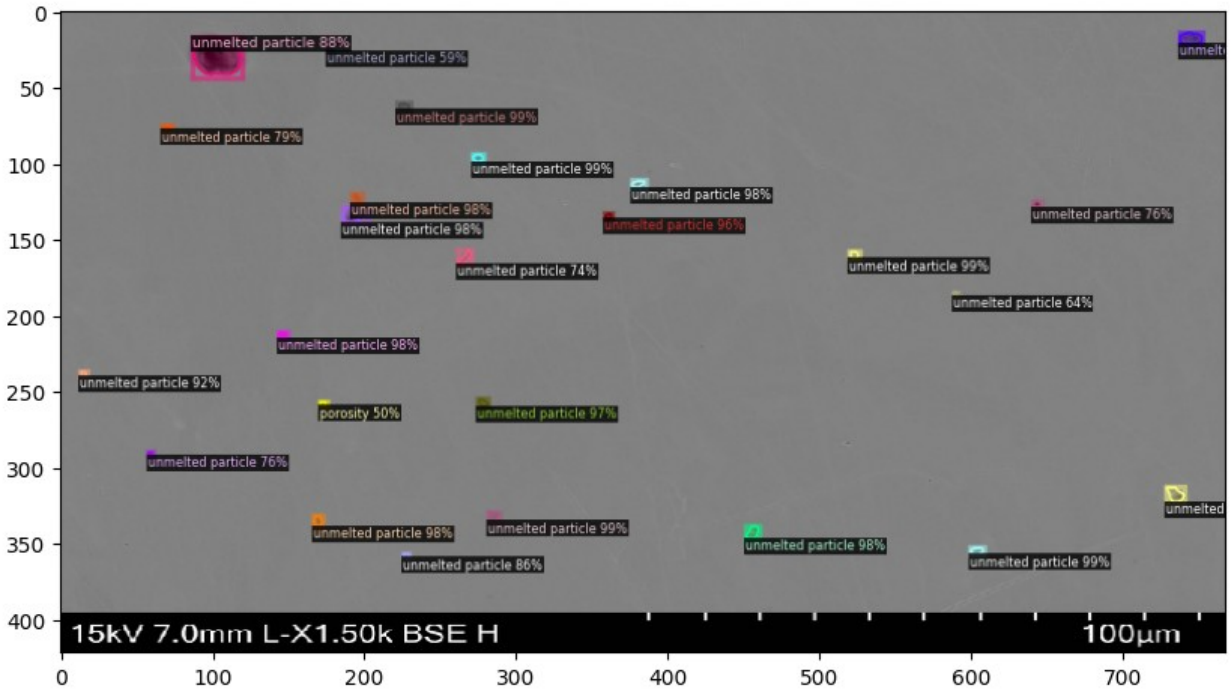

unmelted particle 95%
unmelted particle 83%
unmelted particle 94%
unmelted particle 100%
unmelted particle 76%
unmelted particle 56%
porosity 84%
unmelted particle 100%
unmelted particle 99%
unmelted particle 99%
porosity 78%
unmelted particle 99%
15kV 7.0mm L-X1.50k BSE M
100µm
0
100
200
300
400
500
600
700
0
50
100
150
200
250
300
350
400

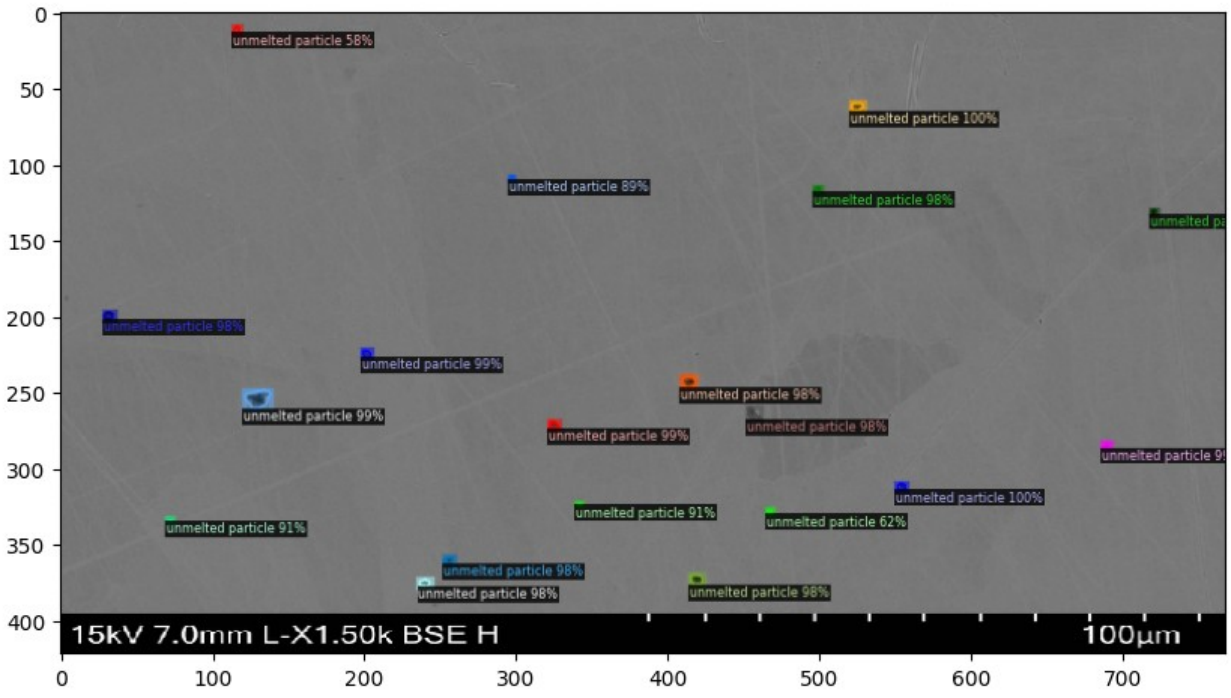


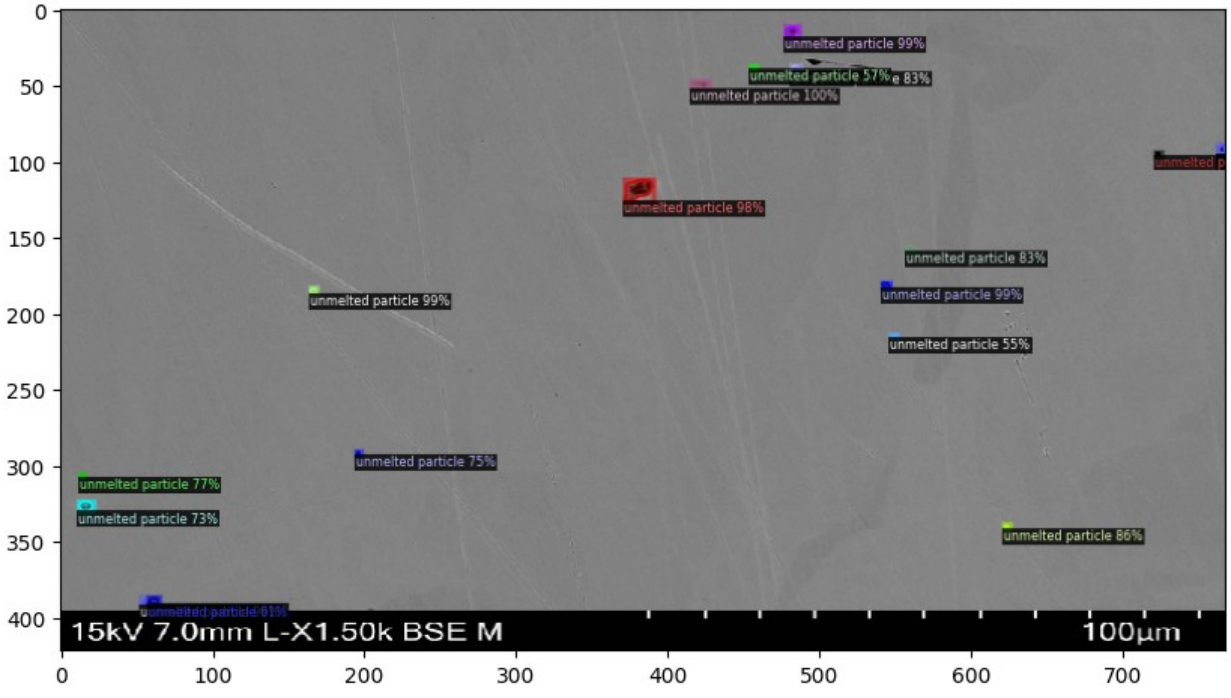


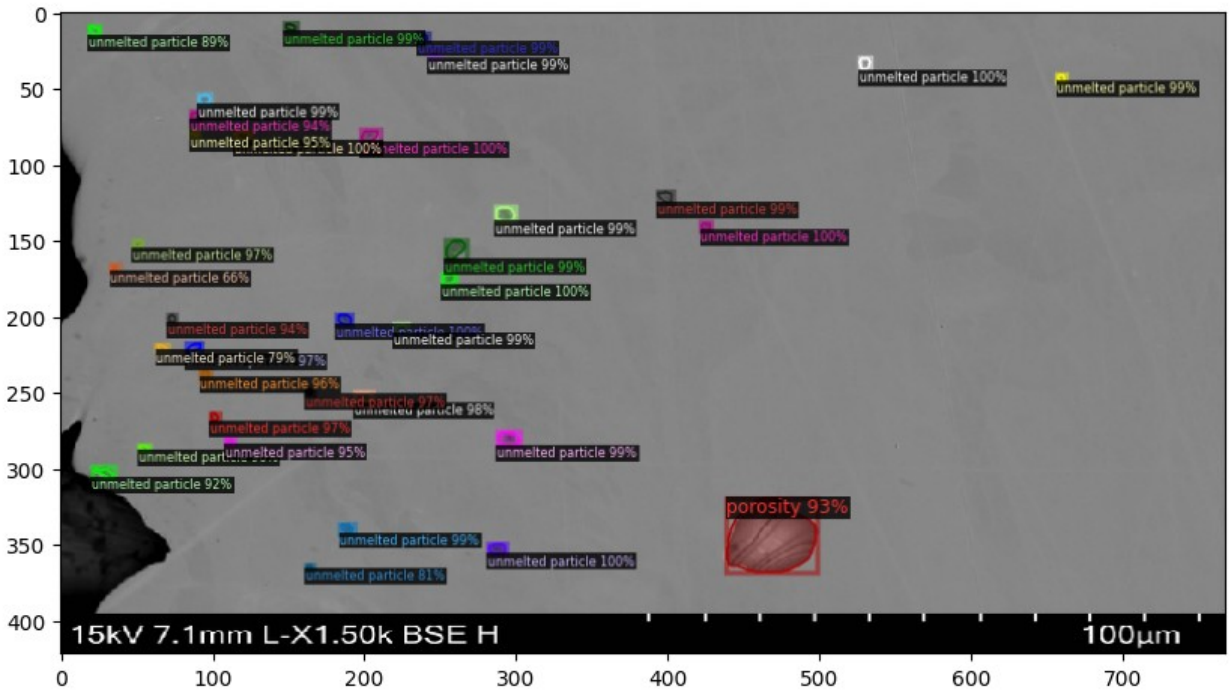

```
from detectron2.utils.visualizer import ColorMode
dataset_dicts = get_r_dicts('/content/drive/MyDrive/Mahabub/test')
for d in random.sample(dataset_dicts, 4):
    im = cv2.imread(d["file_name"])
    outputs = predictor(im)
    v = Visualizer(im[:, :, ::-1],
```

```
                    metadata=r_metadata,
                    scale=0.8,
                    instance_mode=ColorMode.IMAGE_BW   # remove the
colors of unsegmented pixels
    )
    v = v.draw_instance_predictions(outputs["instances"].to("cpu"))
    plt.figure(figsize = (10, 10))
    plt.imshow(cv2.cvtColor(v.get_image()[:, :, ::-1],
cv2.COLOR_BGR2RGB))
    plt.show()
```



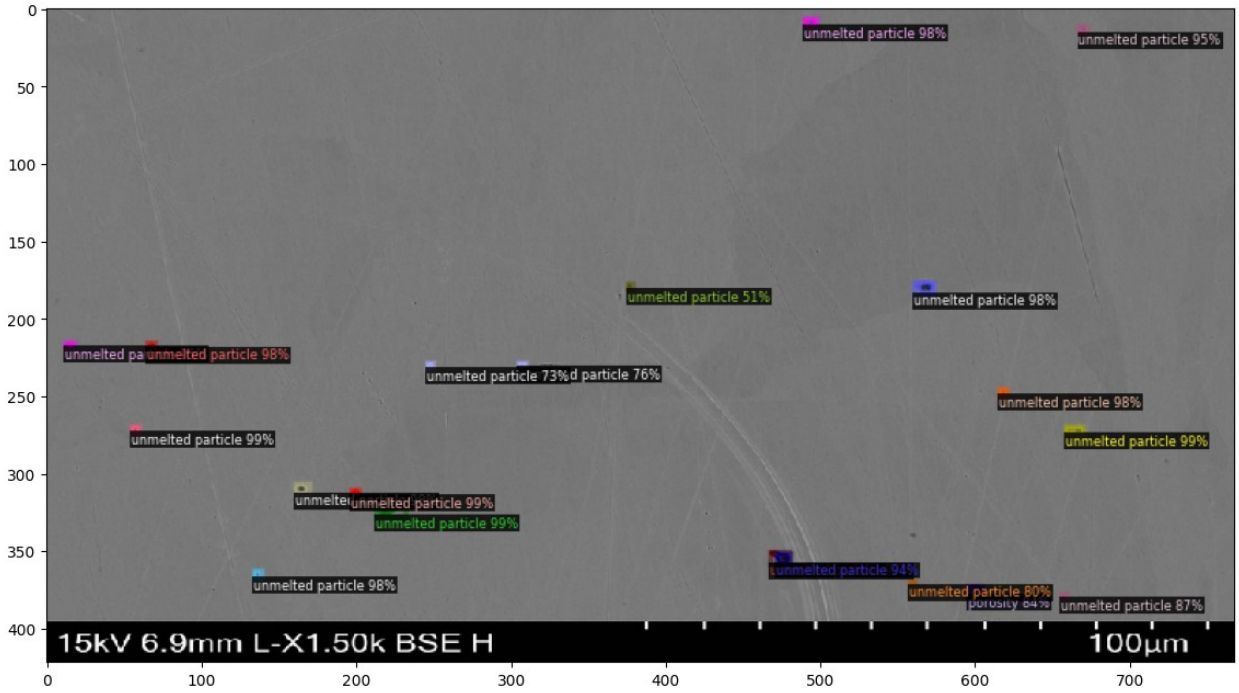

unmelted particle 58%
unmelted particle 100%
unmelted particle 89%
unmelted particle 98%
unmelted particle 98%
unmelted particle 99%
unmelted particle 98%
unmelted particle 99%
unmelted particle 99%
unmelted particle 98%
unmelted particle 100%
unmelted particle 91%
unmelted particle 91%
unmelted particle 62%
unmelted particle 98%
unmelted particle 98%
unmelted particle 98%
15kV 7.0mm L-X1.50k BSE H
100µm
0
50
100
150
200
250
300
350
400
0
100
200
300
400
500
600
700


unmelted particle 99%
unmelted particle 57%
unmelted particle 100%
unmelted particle 98%
unmelted particle 83%
unmelted particle 99%
unmelted particle 99%
unmelted particle 55%
unmelted particle 75%
unmelted particle 77%
unmelted particle 73%
unmelted particle 86%
15kV 7.0mm L-X1.50k BSE M
100µm
0
50
100
150
200
250
300
350
400
0
100
200
300
400
500
600
700




```
from detectron2.utils.visualizer import ColorMode

im =
cv2.imread("/content/drive/MyDrive/Mahabub/test/rsz_slm_square_finalx15k_0060.jpg")
outputs = predictor(im)
v = Visualizer(im[:, :, ::-1],
               metadata=r_metadata,
               scale=0.8,
               instance_mode=ColorMode.IMAGE_BW   # remove the colors of unsegmented pixels
)
v = v.draw_instance_predictions(outputs["instances"].to("cpu"))
plt.figure(figsize = (14, 10))
plt.imshow(cv2.cvtColor(v.get_image()[:, :, ::-1], cv2.COLOR_BGR2RGB))
plt.show()
```




```
from detectron2.evaluation import COCOEvaluator, inference_on_dataset
from detectron2.data import build_detection_test_loader
evaluator = COCOEvaluator("p_train", ['bbox'], False,
output_dir="./output/")
val_loader = build_detection_test_loader(cfg, "p_train")
print(inference_on_dataset(predictor.model, val_loader, evaluator))
```

```
[08/02 21:36:14 d2.evaluation.coco_evaluation]: Trying to convert
'p_train' to COCO format ...
[08/02 21:36:14 d2.data.datasets.coco]: Converting annotations of
dataset 'p_train' to COCO format ...)
[08/02 21:36:14 d2.data.datasets.coco]: Converting dataset dicts into
COCO format
[08/02 21:36:14 d2.data.datasets.coco]: Conversion finished, #images:
42, #annotations: 715
[08/02 21:36:14 d2.data.datasets.coco]: Caching COCO format
annotations at './output/p_train_coco_format.json' ...
[08/02 21:36:14 d2.data.dataset_mapper]: [DatasetMapper] Augmentations
used in inference: [ResizeShortestEdge(short_edge_length=(800, 800),
max_size=1333, sample_style='choice')]
[08/02 21:36:14 d2.data.common]: Serializing the dataset using: <class
'detectron2.data.common._TorchSerializedList'>
[08/02 21:36:14 d2.data.common]: Serializing 42 elements to byte
tensors and concatenating them all ...
[08/02 21:36:14 d2.data.common]: Serialized dataset takes 0.16 MiB
[08/02 21:36:14 d2.evaluation.evaluator]: Start inference on 42
batches
[08/02 21:36:17 d2.evaluation.evaluator]: Inference done 11/42.
```

```
Dataloading: 0.0055 s/iter. Inference: 0.0995 s/iter. Eval: 0.0464
s/iter. Total: 0.1523 s/iter. ETA=0:00:04
[08/02 21:36:22 d2.evaluation.evaluator]: Total inference time:
0:00:05.920175 (0.160005 s / iter per device, on 1 devices)
[08/02 21:36:22 d2.evaluation.evaluator]: Total inference pure compute
time: 0:00:03 (0.100423 s / iter per device, on 1 devices)
[08/02 21:36:22 d2.evaluation.coco_evaluation]: Preparing results for
COCO format ...
[08/02 21:36:22 d2.evaluation.coco_evaluation]: Saving results to
./output/coco_instances_results.json
[08/02 21:36:22 d2.evaluation.coco_evaluation]: Evaluating predictions
with unofficial COCO API...
Loading and preparing results...
DONE (t=0.00s)
creating index...
index created!
[08/02 21:36:22 d2.evaluation.fast_eval_api]: Evaluate annotation type
*bbox*
[08/02 21:36:22 d2.evaluation.fast_eval_api]: COCOeval_opt.evaluate()
finished in 0.06 seconds.
[08/02 21:36:22 d2.evaluation.fast_eval_api]: Accumulating evaluation
results...
[08/02 21:36:22 d2.evaluation.fast_eval_api]:
COCOeval_opt.accumulate() finished in 0.03 seconds.
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all |
maxDets=100 ] = 0.351
 Average Precision  (AP) @[ IoU=0.50      | area=   all |
maxDets=100 ] = 0.580
 Average Precision  (AP) @[ IoU=0.75      | area=   all |
maxDets=100 ] = 0.359
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small |
maxDets=100 ] = 0.333
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium |
maxDets=100 ] = 0.589
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large |
maxDets=100 ] = -1.000
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=
1 ] = 0.135
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=
10 ] = 0.336
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all |
maxDets=100 ] = 0.389
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small |
maxDets=100 ] = 0.375
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium |
maxDets=100 ] = 0.617
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large |
maxDets=100 ] = -1.000
[08/02 21:36:22 d2.evaluation.coco_evaluation]: Evaluation results for
```

```
bbox:
|   AP   |  AP50  |  AP75  |  APs   |  APm   |  APl  |
|:------:|:------:|:------:|:------:|:------:|:-----:|
| 35.069 | 57.950 | 35.898 | 33.330 | 58.935 |  nan  |
[08/02 21:36:22 d2.evaluation.coco_evaluation]: Some metrics cannot be
computed and is shown as NaN.
[08/02 21:36:22 d2.evaluation.coco_evaluation]: Per-category bbox AP:
| category          | AP     | category   | AP     | category   | AP
|
|:------------------|:-------|:-----------|:-------|:-----------|:----
--|
| unmelted particle | 45.680 | porosity   | 59.527 | microcrack |
0.000 |
OrderedDict([('bbox', {'AP': 35.06909121680845, 'AP50':
57.95042338370637, 'AP75': 35.89796088735046, 'APs':
33.33042508424789, 'APm': 58.93515542030394, 'APl': nan, 'AP-unmelted
particle': 45.67987254228592, 'AP-porosity': 59.52740110813942, 'AP-
microcrack': 0.0})])

import cv2
import numpy as np
import json
from detectron2.config import get_cfg
from detectron2.engine import DefaultPredictor
from detectron2.utils.visualizer import Visualizer
from detectron2.data import MetadataCatalog
from google.colab.patches import cv2_imshow

# Conversion factor: 1 pixel = 0.1 cm (hypothetical value)
conversion_factor = 0.1  # Adjust this value based on your specific
conversion factor

# Load JSON annotations
annotations_path =
'/content/drive/MyDrive/Mahabub/train/rsz_slm_square_finalx15k_0014.js
on'
with open(annotations_path) as f:
    annotations_data = json.load(f)

# Extract annotations
annotations = annotations_data['shapes']

# Load corresponding image
image_path =
'/content/drive/MyDrive/Mahabub/train/rsz_slm_square_finalx15k_0014.jp
g'
image = cv2.imread(image_path)

# Create a black mask image for the background
mask = np.zeros_like(image[:, :, 0], dtype=np.uint8)
```

```
# Initialize variables for area calculations
cracks = []
unmelted_particle_area = 0
microcrack_area = 0
porosity_area = 0

# Iterate through annotations and calculate size, shape, volume, and
area for each crack
for annotation in annotations:
    # Extract label and points
    label = annotation['label']
    points = annotation['points']

    # Extract bounding box coordinates
    xmin = int(min(points, key=lambda x: x[0])[0])
    ymin = int(min(points, key=lambda x: x[1])[1])
    xmax = int(max(points, key=lambda x: x[0])[0])
    ymax = int(max(points, key=lambda x: x[1])[1])

    # Extract segmentation mask
    object_mask = np.zeros_like(image[:, :, 0], dtype=np.uint8)
    cv2.fillPoly(object_mask, np.array([points], dtype=np.int32), 255)

    # Update the main mask based on the label
    if label == 'porosity':
        mask = cv2.bitwise_or(mask, object_mask)
        color = (0, 255, 0)  # Green for porosity
        porosity_area += np.sum(object_mask)
    elif label == 'microcrack':
        mask = cv2.bitwise_or(mask, object_mask)
        color = (0, 0, 255)  # Red for microcrack
        microcrack_area += np.sum(object_mask)
    elif label == 'unmelted particle':
        mask = cv2.bitwise_or(mask, object_mask)
        color = (255, 0, 0)  # Blue for unmelted particle
        unmelted_particle_area += np.sum(object_mask)
    else:
        color = (255, 255, 255)  # White for other objects

    # Draw bounding box and label on the image
    cv2.rectangle(image, (xmin, ymin), (xmax, ymax), color, 2)
    cv2.putText(image, label, (xmin, ymin - 10),
cv2.FONT_HERSHEY_SIMPLEX, 0.9, color, 2)

    # Calculate the size of the crack (length, width, depth) in
centimeters
    length_cm = (xmax - xmin) * conversion_factor
    width_cm = (ymax - ymin) * conversion_factor
    depth_cm = 0.1  # Assuming the depth is 0.1 cm (hypothetical
```

```
value)

    # Calculate the volume of the crack in cubic centimeters (cc)
    volume_cc = length_cm * width_cm * depth_cm

    # Create a dictionary to store crack information
    crack = {
        'label': label,
        'length_cm': length_cm,
        'width_cm': width_cm,
        'depth_cm': depth_cm,
        'volume_cc': volume_cc,
        'area': np.sum(object_mask)
    }

    # Add the crack to the list of cracks
    cracks.append(crack)

# Apply the mask to the original image
masked_image = cv2.bitwise_and(image, image, mask=mask)

# Create a Detectron2 configuration
cfg = get_cfg()
cfg.merge_from_file(model_zoo.get_config_file("COCO-
InstanceSegmentation/mask_rcnn_R_50_FPN_3x.yaml"))
cfg.MODEL.ROI_HEADS.SCORE_THRESH_TEST = 0.5
cfg.MODEL.WEIGHTS = model_zoo.get_checkpoint_url("COCO-
InstanceSegmentation/mask_rcnn_R_50_FPN_3x.yaml")
predictor = DefaultPredictor(cfg)

# Run the Mask R-CNN model on the image
outputs = predictor(image)

# Visualize the predictions
v = Visualizer(image[:, :, ::-1],
MetadataCatalog.get(cfg.DATASETS.TRAIN[0]), scale=1.2)
out = v.draw_instance_predictions(outputs["instances"].to("cpu"))

# Get the annotated image
annotated_image = out.get_image()[:, :, ::-1]

# Calculate average areas
num_unmelted_particles = sum(1 for annotation in annotations if
annotation['label'] == 'unmelted particle')
num_microcracks = sum(1 for annotation in annotations if
annotation['label'] == 'microcrack')
num_porosities = sum(1 for annotation in annotations if
annotation['label'] == 'porosity')

average_unmelted_particle_area = (unmelted_particle_area /
```

```
num_unmelted_particles) * (conversion_factor ** 2) if
num_unmelted_particles > 0 else 0
average_microcrack_area = (microcrack_area / num_microcracks) *
(conversion_factor ** 2) if num_microcracks > 0 else 0
average_porosity_area = (porosity_area / num_porosities) *
(conversion_factor ** 2) if num_porosities > 0 else 0

# Print crack information
for i, crack in enumerate(cracks):
    print(f"Crack {i+1}:")
    print(f"Label: {crack['label']}")
    print(f"Length: {crack['length_cm']:.2f} cm")
    print(f"Width: {crack['width_cm']:.2f} cm")
    print(f"Depth: {crack['depth_cm']:.2f} cm")
    print(f"Volume: {crack['volume_cc']:.2f} cc")
    print(f"Area: {crack['area']} pixels^2\n")

# Print average area calculations
print(f"Average area of microcracks: {average_microcrack_area:.2f}
cm^2")
print(f"Average area of porosity: {average_porosity_area:.2f} cm^2")
print(f"Average area of unmelted particles:
{average_unmelted_particle_area:.2f} cm^2")

# Display the images
cv2_imshow(image)
cv2_imshow(masked_image)
cv2_imshow(annotated_image)
```

```
[07/30 21:46:57 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: microcrack
Length: 8.10 cm
Width: 12.00 cm
Depth: 0.10 cm
Volume: 9.72 cc
Area: 514845 pixels^2

Crack 2:
Label: unmelted particle
Length: 1.60 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.16 cc
Area: 33660 pixels^2

Crack 3:
```

```
Label: unmelted particle
Length: 3.00 cm
Width: 2.10 cm
Depth: 0.10 cm
Volume: 0.63 cc
Area: 118065 pixels^2

Crack 4:
Label: unmelted particle
Length: 0.60 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 9180 pixels^2

Crack 5:
Label: unmelted particle
Length: 2.20 cm
Width: 1.70 cm
Depth: 0.10 cm
Volume: 0.37 cc
Area: 61455 pixels^2

Crack 6:
Label: unmelted particle
Length: 0.90 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.08 cc
Area: 16575 pixels^2

Crack 7:
Label: unmelted particle
Length: 2.50 cm
Width: 2.50 cm
Depth: 0.10 cm
Volume: 0.62 cc
Area: 99195 pixels^2

Crack 8:
Label: porosity
Length: 1.20 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.11 cc
Area: 25755 pixels^2

Crack 9:
Label: porosity
Length: 0.70 cm
```

```
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 11985 pixels^2

Crack 10:
Label: unmelted particle
Length: 0.80 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 14280 pixels^2

Crack 11:
Label: unmelted particle
Length: 0.90 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 10710 pixels^2

Crack 12:
Label: unmelted particle
Length: 0.40 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 6630 pixels^2

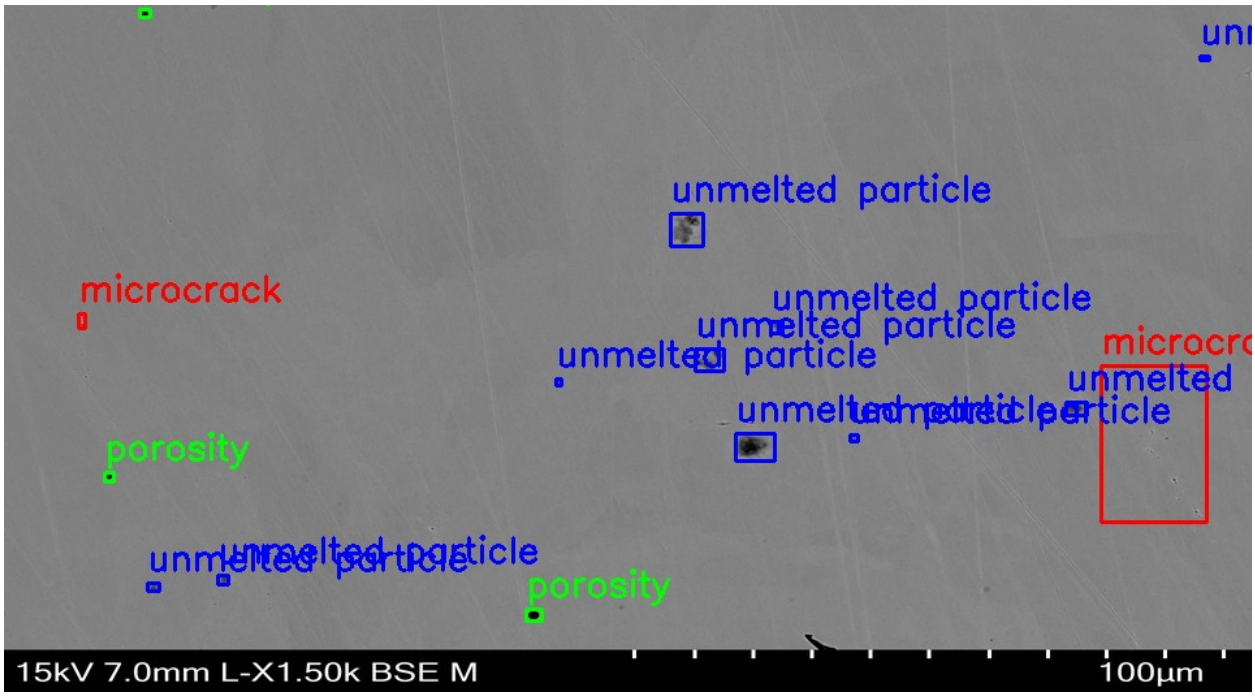
Crack 13:
Label: porosity
Length: 0.80 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 11985 pixels^2

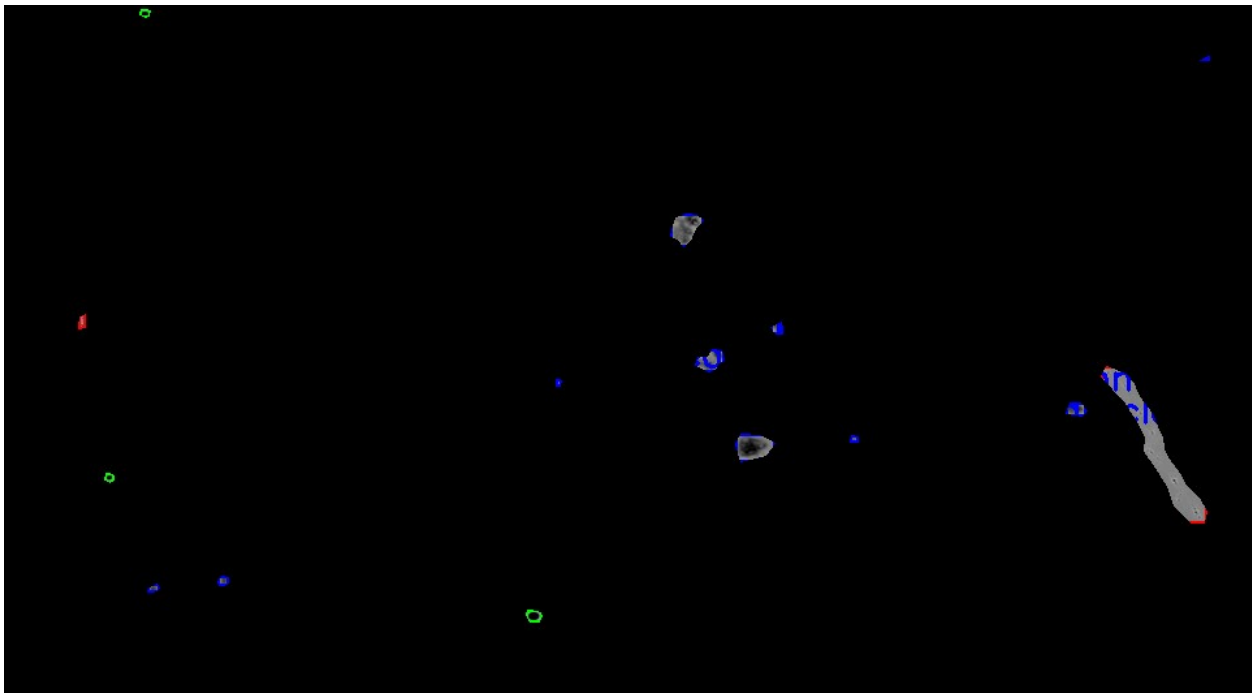
Crack 14:
Label: microcrack
Length: 0.50 cm
Width: 1.10 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 14535 pixels^2

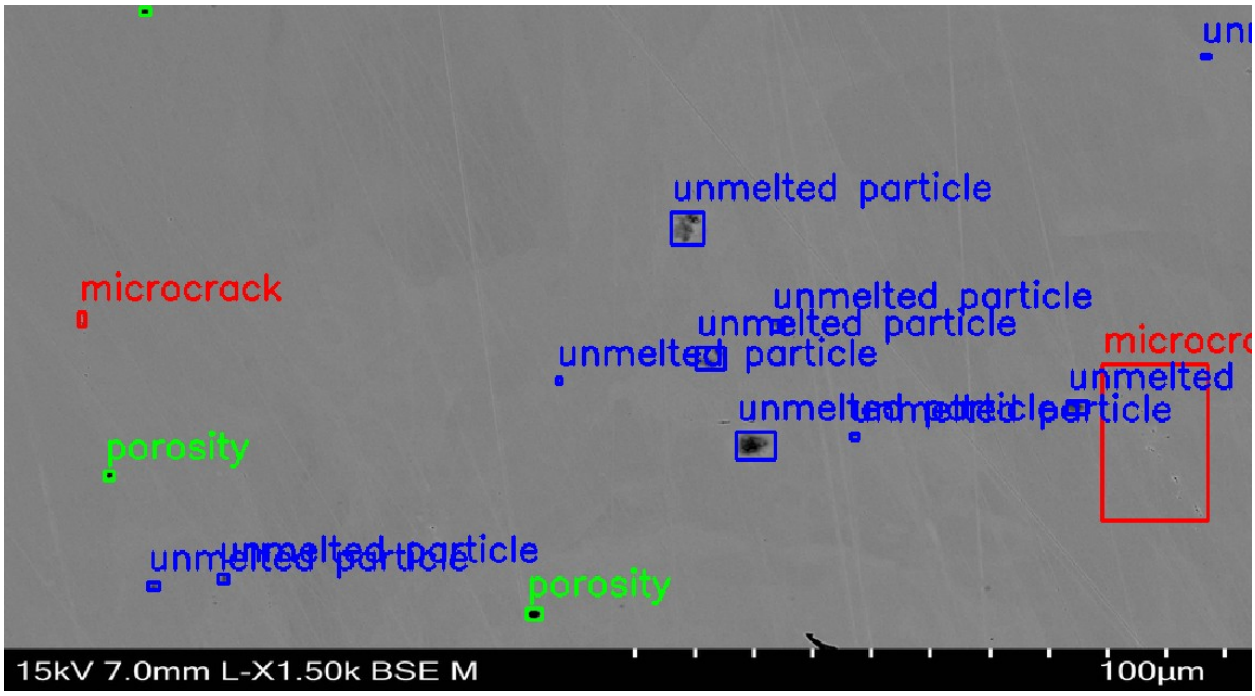
Crack 15:
Label: unmelted particle
Length: 0.70 cm
Width: 0.30 cm
Depth: 0.10 cm
```

```
Volume: 0.02 cc
Area: 5100 pixels^2

Average area of microcracks: 2646.90 cm^2
Average area of porosity: 165.75 cm^2
Average area of unmelted particles: 374.85 cm^2
```








```
import cv2
import numpy as np
import json
import os
from detectron2.config import get_cfg
from detectron2.engine import DefaultPredictor
from detectron2.utils.visualizer import Visualizer
from detectron2.data import MetadataCatalog
from google.colab.patches import cv2_imshow
# Conversion factor: 1 pixel = 0.1 cm (hypothetical value)
conversion_factor = 0.1  # Adjust this value based on your specific
conversion factor

# Path to the directory containing the images and JSON files
data_dir = '/content/drive/MyDrive/Mahabub/train'  # Replace with the
actual path to the directory

# Iterate over all files in the directory
for filename in os.listdir(data_dir):
    if filename.endswith('.json'):
        # Load JSON annotations
        annotations_path = os.path.join(data_dir, filename)
        with open(annotations_path) as f:
            annotations_data = json.load(f)

        # Extract annotations
        annotations = annotations_data['shapes']

        # Load corresponding image
```

```
        image_filename = os.path.splitext(filename)[0] + '.jpg'
        image_path = os.path.join(data_dir, image_filename)
        image = cv2.imread(image_path)

        # Create a black mask image for the background
        mask = np.zeros_like(image[:, :, 0], dtype=np.uint8)

        # Initialize variables for area calculations
        cracks = []
        unmelted_particle_area = 0
        microcrack_area = 0
        porosity_area = 0

        # Iterate through annotations and calculate size, shape,
volume, and area for each crack
        for annotation in annotations:
            # Extract label and points
            label = annotation['label']
            points = annotation['points']

            # Extract bounding box coordinates
            xmin = int(min(points, key=lambda x: x[0])[0])
            ymin = int(min(points, key=lambda x: x[1])[1])
            xmax = int(max(points, key=lambda x: x[0])[0])
            ymax = int(max(points, key=lambda x: x[1])[1])

            # Extract segmentation mask
            object_mask = np.zeros_like(image[:, :, 0],
dtype=np.uint8)
            cv2.fillPoly(object_mask, np.array([points],
dtype=np.int32), 255)

            # Update the main mask based on the label
            if label == 'porosity':
                mask = cv2.bitwise_or(mask, object_mask)
                color = (0, 255, 0)  # Green for porosity
                porosity_area += np.sum(object_mask)
            elif label == 'microcrack':
                mask = cv2.bitwise_or(mask, object_mask)
                color = (0, 0, 255)  # Red for microcrack
                microcrack_area += np.sum(object_mask)
            elif label == 'unmelted particle':
                mask = cv2.bitwise_or(mask, object_mask)
                color = (255, 0, 0)  # Blue for unmelted particle
                unmelted_particle_area += np.sum(object_mask)
            else:
                color = (255, 255, 255)  # White for other objects

            # Draw bounding box and label on the image
            cv2.rectangle(image, (xmin, ymin), (xmax, ymax), color, 2)
```

```
            cv2.putText(image, label, (xmin, ymin - 10),
cv2.FONT_HERSHEY_SIMPLEX, 0.9, color, 2)

            # Calculate the size of the crack (length, width, depth)
in centimeters
            length_cm = (xmax - xmin) * conversion_factor
            width_cm = (ymax - ymin) * conversion_factor
            depth_cm = 0.1  # Assuming the depth is 0.1 cm
(hypothetical value)

            # Calculate the volume of the crack in cubic centimeters
(cc)
            volume_cc = length_cm * width_cm * depth_cm

            # Create a dictionary to store crack information
            crack = {
                'label': label,
                'length_cm': length_cm,
                'width_cm': width_cm,
                'depth_cm': depth_cm,
                'volume_cc': volume_cc,
                'area': np.sum(object_mask)
            }

            # Add the crack to the list of cracks
            cracks.append(crack)

        # Apply the mask to the original image
        masked_image = cv2.bitwise_and(image, image, mask=mask)

        # Create a Detectron2 configuration
        cfg = get_cfg()
        cfg.merge_from_file(model_zoo.get_config_file("COCO-
InstanceSegmentation/mask_rcnn_R_50_FPN_3x.yaml"))
        cfg.MODEL.ROI_HEADS.SCORE_THRESH_TEST = 0.5
        cfg.MODEL.WEIGHTS = model_zoo.get_checkpoint_url("COCO-
InstanceSegmentation/mask_rcnn_R_50_FPN_3x.yaml")
        predictor = DefaultPredictor(cfg)

        # Run the Mask R-CNN model on the image
        outputs = predictor(image)

        # Visualize the predictions
        v = Visualizer(image[:, :, ::-1],
MetadataCatalog.get(cfg.DATASETS.TRAIN[0]), scale=1.2)
        out =
v.draw_instance_predictions(outputs["instances"].to("cpu"))

        # Get the annotated image
        annotated_image = out.get_image()[:, :, ::-1]
```

```
        # Calculate average areas
        num_unmelted_particles = sum(1 for annotation in annotations
if annotation['label'] == 'unmelted particle')
        num_microcracks = sum(1 for annotation in annotations if
annotation['label'] == 'microcrack')
        num_porosities = sum(1 for annotation in annotations if
annotation['label'] == 'porosity')

        average_unmelted_particle_area = (unmelted_particle_area /
num_unmelted_particles) * (
                conversion_factor ** 2) if num_unmelted_particles > 0
else 0
        average_microcrack_area = (microcrack_area / num_microcracks)
* (
                conversion_factor ** 2) if num_microcracks > 0 else 0
        average_porosity_area = (porosity_area / num_porosities) * (
                conversion_factor ** 2) if num_porosities > 0 else 0

        # Print crack information
        for i, crack in enumerate(cracks):
            print(f"Crack {i + 1}:")
            print(f"Label: {crack['label']}")
            print(f"Length: {crack['length_cm']:.2f} cm")
            print(f"Width: {crack['width_cm']:.2f} cm")
            print(f"Depth: {crack['depth_cm']:.2f} cm")
            print(f"Volume: {crack['volume_cc']:.2f} cc")
            print(f"Area: {crack['area']} pixels^2\n")

        # Print average area calculations
        print(f"Average area of microcracks:
{average_microcrack_area:.2f} cm^2")
        print(f"Average area of unmelted particles:
{average_unmelted_particle_area:.2f} cm^2")
        print(f"Average area of porosities:
{average_porosity_area:.2f} cm^2\n")



Streaming output truncated to the last 5000 lines.
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 5610 pixels^2

Crack 20:
Label: unmelted particle
Length: 0.50 cm
Width: 0.30 cm
Depth: 0.10 cm
```

```
Volume: 0.02 cc
Area: 4335 pixels^2

Average area of microcracks: 0.00 cm^2
Average area of unmelted particles: 150.29 cm^2
Average area of porosities: 699.98 cm^2

[06/16 19:11:05 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: unmelted particle
Length: 4.10 cm
Width: 2.70 cm
Depth: 0.10 cm
Volume: 1.11 cc
Area: 186915 pixels^2

Crack 2:
Label: unmelted particle
Length: 0.90 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.07 cc
Area: 17340 pixels^2

Crack 3:
Label: unmelted particle
Length: 0.60 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 9945 pixels^2

Crack 4:
Label: unmelted particle
Length: 2.30 cm
Width: 1.10 cm
Depth: 0.10 cm
Volume: 0.25 cc
Area: 48450 pixels^2

Crack 5:
Label: unmelted particle
Length: 2.70 cm
Width: 1.40 cm
Depth: 0.10 cm
Volume: 0.38 cc
Area: 82875 pixels^2
```

```
Crack 6:
Label: unmelted particle
Length: 1.50 cm
Width: 1.10 cm
Depth: 0.10 cm
Volume: 0.17 cc
Area: 31110 pixels^2

Crack 7:
Label: unmelted particle
Length: 1.00 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 14280 pixels^2

Crack 8:
Label: unmelted particle
Length: 1.70 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.14 cc
Area: 25500 pixels^2

Crack 9:
Label: unmelted particle
Length: 0.50 cm
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 4845 pixels^2

Crack 10:
Label: unmelted particle
Length: 0.60 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 7140 pixels^2

Crack 11:
Label: unmelted particle
Length: 0.40 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 6375 pixels^2

Crack 12:
```

```
Label: unmelted particle
Length: 1.40 cm
Width: 1.20 cm
Depth: 0.10 cm
Volume: 0.17 cc
Area: 30855 pixels^2

Crack 13:
Label: unmelted particle
Length: 0.90 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 9435 pixels^2

Crack 14:
Label: unmelted particle
Length: 0.80 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 9435 pixels^2

Crack 15:
Label: unmelted particle
Length: 0.80 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 10200 pixels^2

Crack 16:
Label: unmelted particle
Length: 1.00 cm
Width: 1.30 cm
Depth: 0.10 cm
Volume: 0.13 cc
Area: 28560 pixels^2

Crack 17:
Label: unmelted particle
Length: 0.60 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 4845 pixels^2

Crack 18:
Label: unmelted particle
Length: 0.90 cm
```

```
Width: 1.60 cm
Depth: 0.10 cm
Volume: 0.14 cc
Area: 26265 pixels^2

Average area of microcracks: 0.00 cm^2
Average area of unmelted particles: 307.98 cm^2
Average area of porosities: 0.00 cm^2

[06/16 19:11:06 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: porosity
Length: 0.50 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 7140 pixels^2

Crack 2:
Label: unmelted particle
Length: 1.60 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.13 cc
Area: 26775 pixels^2

Crack 3:
Label: unmelted particle
Length: 0.50 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 6120 pixels^2

Crack 4:
Label: unmelted particle
Length: 1.60 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.16 cc
Area: 33660 pixels^2

Crack 5:
Label: unmelted particle
Length: 1.10 cm
Width: 1.40 cm
Depth: 0.10 cm
```

```
Volume: 0.15 cc
Area: 28560 pixels^2

Crack 6:
Label: unmelted particle
Length: 1.70 cm
Width: 1.30 cm
Depth: 0.10 cm
Volume: 0.22 cc
Area: 40800 pixels^2

Crack 7:
Label: unmelted particle
Length: 0.90 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 9435 pixels^2

Crack 8:
Label: unmelted particle
Length: 1.10 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.10 cc
Area: 21420 pixels^2

Crack 9:
Label: unmelted particle
Length: 1.20 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.10 cc
Area: 19890 pixels^2

Crack 10:
Label: unmelted particle
Length: 0.80 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 9435 pixels^2

Crack 11:
Label: unmelted particle
Length: 3.10 cm
Width: 2.70 cm
Depth: 0.10 cm
Volume: 0.84 cc
Area: 109395 pixels^2
```

```
Crack 12:
Label: unmelted particle
Length: 1.80 cm
Width: 1.30 cm
Depth: 0.10 cm
Volume: 0.23 cc
Area: 52275 pixels^2

Crack 13:
Label: unmelted particle
Length: 1.60 cm
Width: 1.20 cm
Depth: 0.10 cm
Volume: 0.19 cc
Area: 39015 pixels^2

Crack 14:
Label: unmelted particle
Length: 0.60 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 6630 pixels^2

Crack 15:
Label: unmelted particle
Length: 1.00 cm
Width: 1.30 cm
Depth: 0.10 cm
Volume: 0.13 cc
Area: 24735 pixels^2

Crack 16:
Label: unmelted particle
Length: 1.80 cm
Width: 1.40 cm
Depth: 0.10 cm
Volume: 0.25 cc
Area: 47175 pixels^2

Crack 17:
Label: unmelted particle
Length: 1.50 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.15 cc
Area: 33660 pixels^2

Crack 18:
```

```
Label: unmelted particle
Length: 2.00 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.20 cc
Area: 37230 pixels^2

Crack 19:
Label: unmelted particle
Length: 0.80 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 10710 pixels^2

Crack 20:
Label: unmelted particle
Length: 0.40 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 3060 pixels^2

Crack 21:
Label: porosity
Length: 1.00 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.09 cc
Area: 15555 pixels^2

Crack 22:
Label: unmelted particle
Length: 1.40 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.11 cc
Area: 29580 pixels^2

Crack 23:
Label: unmelted particle
Length: 2.90 cm
Width: 2.00 cm
Depth: 0.10 cm
Volume: 0.58 cc
Area: 130560 pixels^2

Crack 24:
Label: unmelted particle
Length: 0.50 cm
```

```
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 5865 pixels^2

Crack 25:
Label: unmelted particle
Length: 0.60 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 9690 pixels^2

Crack 26:
Label: unmelted particle
Length: 0.50 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 6885 pixels^2

Crack 27:
Label: unmelted particle
Length: 0.60 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 9435 pixels^2

Average area of microcracks: 0.00 cm^2
Average area of unmelted particles: 300.80 cm^2
Average area of porosities: 113.48 cm^2

[06/16 19:11:07 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: unmelted particle
Length: 2.80 cm
Width: 2.20 cm
Depth: 0.10 cm
Volume: 0.62 cc
Area: 106335 pixels^2

Crack 2:
Label: unmelted particle
Length: 1.00 cm
Width: 0.70 cm
Depth: 0.10 cm
```

```
Volume: 0.07 cc
Area: 15300 pixels^2

Crack 3:
Label: unmelted particle
Length: 1.10 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.08 cc
Area: 15810 pixels^2

Crack 4:
Label: unmelted particle
Length: 1.20 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.10 cc
Area: 22950 pixels^2

Crack 5:
Label: unmelted particle
Length: 1.50 cm
Width: 1.50 cm
Depth: 0.10 cm
Volume: 0.23 cc
Area: 40545 pixels^2

Crack 6:
Label: unmelted particle
Length: 1.00 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 10965 pixels^2

Crack 7:
Label: unmelted particle
Length: 1.20 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.07 cc
Area: 12240 pixels^2

Crack 8:
Label: unmelted particle
Length: 0.90 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 9945 pixels^2
```

```
Crack 9:
Label: unmelted particle
Length: 1.00 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 9945 pixels^2

Crack 10:
Label: unmelted particle
Length: 0.60 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 8160 pixels^2

Average area of microcracks: 0.00 cm^2
Average area of unmelted particles: 252.20 cm^2
Average area of porosities: 0.00 cm^2

[06/16 19:11:08 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: unmelted particle
Length: 1.10 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.10 cc
Area: 23460 pixels^2

Crack 2:
Label: unmelted particle
Length: 0.80 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 14535 pixels^2

Crack 3:
Label: unmelted particle
Length: 0.80 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 11985 pixels^2

Crack 4:
```

```
Label: unmelted particle
Length: 0.60 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 5355 pixels^2

Crack 5:
Label: porosity
Length: 1.20 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.10 cc
Area: 25245 pixels^2

Crack 6:
Label: unmelted particle
Length: 0.80 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 12750 pixels^2

Crack 7:
Label: unmelted particle
Length: 0.60 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 9435 pixels^2

Crack 8:
Label: unmelted particle
Length: 1.00 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.08 cc
Area: 16320 pixels^2

Crack 9:
Label: unmelted particle
Length: 0.50 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 6630 pixels^2

Crack 10:
Label: unmelted particle
Length: 0.60 cm
```

```
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 9180 pixels^2

Crack 11:
Label: unmelted particle
Length: 0.80 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 9945 pixels^2

Crack 12:
Label: unmelted particle
Length: 0.90 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 14280 pixels^2

Crack 13:
Label: unmelted particle
Length: 0.80 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 8415 pixels^2

Crack 14:
Label: unmelted particle
Length: 0.90 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 11475 pixels^2

Crack 15:
Label: porosity
Length: 0.50 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 5100 pixels^2

Crack 16:
Label: unmelted particle
Length: 0.60 cm
Width: 0.40 cm
Depth: 0.10 cm
```

```
Volume: 0.02 cc
Area: 7395 pixels^2

Crack 17:
Label: unmelted particle
Length: 0.50 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 8415 pixels^2

Crack 18:
Label: unmelted particle
Length: 1.70 cm
Width: 1.10 cm
Depth: 0.10 cm
Volume: 0.19 cc
Area: 36975 pixels^2

Crack 19:
Label: unmelted particle
Length: 0.60 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 10710 pixels^2

Average area of microcracks: 0.00 cm^2
Average area of unmelted particles: 127.80 cm^2
Average area of porosities: 151.73 cm^2

[06/16 19:11:09 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: unmelted particle
Length: 2.50 cm
Width: 2.00 cm
Depth: 0.10 cm
Volume: 0.50 cc
Area: 95625 pixels^2

Crack 2:
Label: unmelted particle
Length: 2.80 cm
Width: 1.50 cm
Depth: 0.10 cm
Volume: 0.42 cc
Area: 87720 pixels^2
```

```
Crack 3:
Label: unmelted particle
Length: 1.50 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.14 cc
Area: 21675 pixels^2

Crack 4:
Label: unmelted particle
Length: 1.40 cm
Width: 1.10 cm
Depth: 0.10 cm
Volume: 0.15 cc
Area: 35190 pixels^2

Crack 5:
Label: unmelted particle
Length: 0.70 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 15300 pixels^2

Crack 6:
Label: unmelted particle
Length: 0.40 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 6630 pixels^2

Crack 7:
Label: unmelted particle
Length: 1.00 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.08 cc
Area: 16575 pixels^2

Average area of microcracks: 0.00 cm^2
Average area of unmelted particles: 398.16 cm^2
Average area of porosities: 0.00 cm^2

[06/16 19:11:10 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
```

```
Label: unmelted particle
Length: 1.90 cm
Width: 1.10 cm
Depth: 0.10 cm
Volume: 0.21 cc
Area: 37485 pixels^2

Crack 2:
Label: unmelted particle
Length: 1.50 cm
Width: 1.30 cm
Depth: 0.10 cm
Volume: 0.20 cc
Area: 47430 pixels^2

Crack 3:
Label: unmelted particle
Length: 0.80 cm
Width: 1.30 cm
Depth: 0.10 cm
Volume: 0.10 cc
Area: 21675 pixels^2

Crack 4:
Label: unmelted particle
Length: 1.70 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.14 cc
Area: 29325 pixels^2

Crack 5:
Label: unmelted particle
Length: 1.90 cm
Width: 1.30 cm
Depth: 0.10 cm
Volume: 0.25 cc
Area: 45645 pixels^2

Crack 6:
Label: unmelted particle
Length: 0.70 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 11220 pixels^2

Crack 7:
Label: unmelted particle
Length: 0.70 cm
```

```
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 10200 pixels^2

Crack 8:
Label: unmelted particle
Length: 0.80 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 12750 pixels^2

Crack 9:
Label: unmelted particle
Length: 0.50 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 6885 pixels^2

Crack 10:
Label: unmelted particle
Length: 1.90 cm
Width: 1.10 cm
Depth: 0.10 cm
Volume: 0.21 cc
Area: 43350 pixels^2

Crack 11:
Label: unmelted particle
Length: 1.20 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.10 cc
Area: 19635 pixels^2

Crack 12:
Label: porosity
Length: 0.30 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.01 cc
Area: 3315 pixels^2

Crack 13:
Label: unmelted particle
Length: 2.40 cm
Width: 1.70 cm
Depth: 0.10 cm
```

```
Volume: 0.41 cc
Area: 77520 pixels^2

Crack 14:
Label: unmelted particle
Length: 1.40 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.11 cc
Area: 24735 pixels^2

Crack 15:
Label: unmelted particle
Length: 1.50 cm
Width: 1.10 cm
Depth: 0.10 cm
Volume: 0.17 cc
Area: 36210 pixels^2

Crack 16:
Label: unmelted particle
Length: 0.60 cm
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 6120 pixels^2

Crack 17:
Label: unmelted particle
Length: 0.60 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 9690 pixels^2

Crack 18:
Label: unmelted particle
Length: 0.50 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 5355 pixels^2

Crack 19:
Label: unmelted particle
Length: 0.50 cm
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 5100 pixels^2
```

```
Average area of microcracks: 0.00 cm^2
Average area of unmelted particles: 250.18 cm^2
Average area of porosities: 33.15 cm^2

[06/16 19:11:11 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: unmelted particle
Length: 3.60 cm
Width: 1.90 cm
Depth: 0.10 cm
Volume: 0.68 cc
Area: 141015 pixels^2

Crack 2:
Label: unmelted particle
Length: 5.10 cm
Width: 4.10 cm
Depth: 0.10 cm
Volume: 2.09 cc
Area: 355470 pixels^2

Crack 3:
Label: porosity
Length: 0.90 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 10965 pixels^2

Crack 4:
Label: unmelted particle
Length: 0.40 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 4335 pixels^2

Crack 5:
Label: unmelted particle
Length: 0.90 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 17085 pixels^2

Crack 6:
```

```
Label: unmelted particle
Length: 1.30 cm
Width: 1.20 cm
Depth: 0.10 cm
Volume: 0.16 cc
Area: 31620 pixels^2

Crack 7:
Label: unmelted particle
Length: 1.20 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.10 cc
Area: 17850 pixels^2

Crack 8:
Label: unmelted particle
Length: 0.90 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 15555 pixels^2

Crack 9:
Label: unmelted particle
Length: 1.10 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.10 cc
Area: 21930 pixels^2

Crack 10:
Label: unmelted particle
Length: 0.90 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 14790 pixels^2

Crack 11:
Label: unmelted particle
Length: 0.70 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 9690 pixels^2

Crack 12:
Label: unmelted particle
Length: 0.70 cm
```

```
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 10965 pixels^2

Crack 13:
Label: unmelted particle
Length: 0.60 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 6375 pixels^2

Crack 14:
Label: unmelted particle
Length: 0.90 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 12240 pixels^2

Average area of microcracks: 0.00 cm^2
Average area of unmelted particles: 506.86 cm^2
Average area of porosities: 109.65 cm^2

[06/16 19:11:12 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: unmelted particle
Length: 1.70 cm
Width: 1.50 cm
Depth: 0.10 cm
Volume: 0.26 cc
Area: 39015 pixels^2

Crack 2:
Label: unmelted particle
Length: 1.40 cm
Width: 1.10 cm
Depth: 0.10 cm
Volume: 0.15 cc
Area: 33660 pixels^2

Crack 3:
Label: unmelted particle
Length: 1.80 cm
Width: 0.80 cm
Depth: 0.10 cm
```

```
Volume: 0.14 cc
Area: 30345 pixels^2

Crack 4:
Label: unmelted particle
Length: 1.30 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.12 cc
Area: 28305 pixels^2

Crack 5:
Label: unmelted particle
Length: 0.90 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.07 cc
Area: 15045 pixels^2

Crack 6:
Label: unmelted particle
Length: 1.10 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.09 cc
Area: 20400 pixels^2

Crack 7:
Label: unmelted particle
Length: 1.10 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.10 cc
Area: 22950 pixels^2

Crack 8:
Label: unmelted particle
Length: 1.20 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 13515 pixels^2

Crack 9:
Label: unmelted particle
Length: 0.50 cm
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 2550 pixels^2
```

```
Crack 10:
Label: unmelted particle
Length: 0.90 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.08 cc
Area: 19635 pixels^2

Crack 11:
Label: unmelted particle
Length: 0.70 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 13260 pixels^2

Crack 12:
Label: unmelted particle
Length: 1.10 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.08 cc
Area: 19380 pixels^2

Crack 13:
Label: unmelted particle
Length: 0.40 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 3570 pixels^2

Crack 14:
Label: unmelted particle
Length: 0.80 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 9690 pixels^2

Crack 15:
Label: unmelted particle
Length: 0.60 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 5865 pixels^2

Crack 16:
```

```
Label: unmelted particle
Length: 0.60 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 5610 pixels^2

Crack 17:
Label: unmelted particle
Length: 0.60 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 10455 pixels^2

Crack 18:
Label: unmelted particle
Length: 0.60 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 8160 pixels^2

Crack 19:
Label: unmelted particle
Length: 0.50 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 7650 pixels^2

Average area of microcracks: 0.00 cm^2
Average area of unmelted particles: 162.66 cm^2
Average area of porosities: 0.00 cm^2

[06/16 19:11:13 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: porosity
Length: 1.40 cm
Width: 1.30 cm
Depth: 0.10 cm
Volume: 0.18 cc
Area: 46920 pixels^2

Crack 2:
Label: unmelted particle
Length: 1.60 cm
```

```
Width: 1.20 cm
Depth: 0.10 cm
Volume: 0.19 cc
Area: 40290 pixels^2

Crack 3:
Label: unmelted particle
Length: 1.50 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.15 cc
Area: 38250 pixels^2

Crack 4:
Label: unmelted particle
Length: 1.00 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.08 cc
Area: 21420 pixels^2

Crack 5:
Label: unmelted particle
Length: 0.90 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.09 cc
Area: 18615 pixels^2

Crack 6:
Label: microcrack
Length: 1.30 cm
Width: 2.30 cm
Depth: 0.10 cm
Volume: 0.30 cc
Area: 45390 pixels^2

Crack 7:
Label: unmelted particle
Length: 0.60 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 7140 pixels^2

Crack 8:
Label: unmelted particle
Length: 2.20 cm
Width: 1.60 cm
Depth: 0.10 cm
```

```
Volume: 0.35 cc
Area: 64260 pixels^2

Crack 9:
Label: unmelted particle
Length: 0.90 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 16575 pixels^2

Crack 10:
Label: unmelted particle
Length: 0.80 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 14535 pixels^2

Crack 11:
Label: unmelted particle
Length: 0.90 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 17085 pixels^2

Crack 12:
Label: unmelted particle
Length: 0.90 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 11475 pixels^2

Crack 13:
Label: unmelted particle
Length: 0.70 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 7905 pixels^2

Crack 14:
Label: unmelted particle
Length: 0.70 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 13770 pixels^2
```

```
Crack 15:
Label: unmelted particle
Length: 0.50 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 7905 pixels^2

Crack 16:
Label: unmelted particle
Length: 0.50 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 6885 pixels^2

Crack 17:
Label: unmelted particle
Length: 0.70 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 7650 pixels^2

Average area of microcracks: 453.90 cm^2
Average area of unmelted particles: 195.84 cm^2
Average area of porosities: 469.20 cm^2

[06/16 19:11:14 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: unmelted particle
Length: 2.60 cm
Width: 2.10 cm
Depth: 0.10 cm
Volume: 0.55 cc
Area: 111180 pixels^2

Crack 2:
Label: porosity
Length: 4.50 cm
Width: 2.50 cm
Depth: 0.10 cm
Volume: 1.12 cc
Area: 128775 pixels^2

Crack 3:
```

```
Label: unmelted particle
Length: 0.50 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 7140 pixels^2

Crack 4:
Label: unmelted particle
Length: 1.70 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.17 cc
Area: 36720 pixels^2

Crack 5:
Label: unmelted particle
Length: 1.80 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.14 cc
Area: 27030 pixels^2

Crack 6:
Label: unmelted particle
Length: 1.20 cm
Width: 1.20 cm
Depth: 0.10 cm
Volume: 0.14 cc
Area: 34170 pixels^2

Crack 7:
Label: unmelted particle
Length: 1.20 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.08 cc
Area: 18105 pixels^2

Crack 8:
Label: unmelted particle
Length: 0.60 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 11985 pixels^2

Crack 9:
Label: unmelted particle
Length: 1.40 cm
```

```
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.14 cc
Area: 30345 pixels^2

Crack 10:
Label: unmelted particle
Length: 0.70 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 6630 pixels^2

Crack 11:
Label: unmelted particle
Length: 0.80 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 10200 pixels^2

Crack 12:
Label: unmelted particle
Length: 1.00 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 13770 pixels^2

Average area of microcracks: 0.00 cm^2
Average area of unmelted particles: 279.34 cm^2
Average area of porosities: 1287.75 cm^2

[06/16 19:11:15 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: porosity
Length: 5.90 cm
Width: 2.70 cm
Depth: 0.10 cm
Volume: 1.59 cc
Area: 289170 pixels^2

Crack 2:
Label: unmelted particle
Length: 2.40 cm
Width: 1.70 cm
Depth: 0.10 cm
```

```
Volume: 0.41 cc
Area: 85935 pixels^2

Crack 3:
Label: unmelted particle
Length: 2.00 cm
Width: 1.30 cm
Depth: 0.10 cm
Volume: 0.26 cc
Area: 49470 pixels^2

Crack 4:
Label: microcrack
Length: 1.20 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.11 cc
Area: 23970 pixels^2

Crack 5:
Label: unmelted particle
Length: 1.30 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.10 cc
Area: 25755 pixels^2

Crack 6:
Label: unmelted particle
Length: 0.70 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 9435 pixels^2

Crack 7:
Label: unmelted particle
Length: 0.70 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 10455 pixels^2

Crack 8:
Label: unmelted particle
Length: 0.80 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 11475 pixels^2
```

```
Crack 9:
Label: unmelted particle
Length: 0.40 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 6885 pixels^2

Crack 10:
Label: unmelted particle
Length: 1.40 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.13 cc
Area: 30855 pixels^2

Crack 11:
Label: unmelted particle
Length: 0.60 cm
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 6630 pixels^2

Crack 12:
Label: unmelted particle
Length: 1.20 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.08 cc
Area: 17340 pixels^2

Crack 13:
Label: unmelted particle
Length: 1.80 cm
Width: 1.20 cm
Depth: 0.10 cm
Volume: 0.22 cc
Area: 39525 pixels^2

Crack 14:
Label: unmelted particle
Length: 0.70 cm
Width: 1.20 cm
Depth: 0.10 cm
Volume: 0.08 cc
Area: 14280 pixels^2

Crack 15:
```

```
Label: unmelted particle
Length: 0.70 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 9690 pixels^2

Crack 16:
Label: unmelted particle
Length: 1.00 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 14025 pixels^2

Crack 17:
Label: unmelted particle
Length: 1.10 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.08 cc
Area: 19125 pixels^2

Crack 18:
Label: unmelted particle
Length: 0.50 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 5355 pixels^2

Crack 19:
Label: unmelted particle
Length: 0.50 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 7395 pixels^2

Crack 20:
Label: unmelted particle
Length: 0.60 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 8670 pixels^2

Crack 21:
Label: unmelted particle
Length: 0.60 cm
```

```
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 7905 pixels^2

Crack 22:
Label: unmelted particle
Length: 0.60 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 7140 pixels^2

Crack 23:
Label: unmelted particle
Length: 1.60 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.10 cc
Area: 23715 pixels^2

Average area of microcracks: 239.70 cm^2
Average area of unmelted particles: 195.74 cm^2
Average area of porosities: 2891.70 cm^2

[06/16 19:11:16 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: porosity
Length: 4.30 cm
Width: 3.00 cm
Depth: 0.10 cm
Volume: 1.29 cc
Area: 235620 pixels^2

Crack 2:
Label: unmelted particle
Length: 2.10 cm
Width: 1.80 cm
Depth: 0.10 cm
Volume: 0.38 cc
Area: 60690 pixels^2

Crack 3:
Label: unmelted particle
Length: 0.80 cm
Width: 1.00 cm
Depth: 0.10 cm
```

```
Volume: 0.08 cc
Area: 15810 pixels^2

Crack 4:
Label: unmelted particle
Length: 1.20 cm
Width: 1.10 cm
Depth: 0.10 cm
Volume: 0.13 cc
Area: 30090 pixels^2

Crack 5:
Label: unmelted particle
Length: 1.00 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.10 cc
Area: 24990 pixels^2

Crack 6:
Label: unmelted particle
Length: 1.10 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 12750 pixels^2

Crack 7:
Label: unmelted particle
Length: 1.20 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.10 cc
Area: 19890 pixels^2

Crack 8:
Label: unmelted particle
Length: 1.20 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.12 cc
Area: 24735 pixels^2

Crack 9:
Label: unmelted particle
Length: 1.10 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.08 cc
Area: 16320 pixels^2
```

```
Crack 10:
Label: unmelted particle
Length: 1.70 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.09 cc
Area: 20655 pixels^2

Crack 11:
Label: unmelted particle
Length: 1.70 cm
Width: 1.20 cm
Depth: 0.10 cm
Volume: 0.20 cc
Area: 36465 pixels^2

Crack 12:
Label: unmelted particle
Length: 1.30 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.07 cc
Area: 15300 pixels^2

Crack 13:
Label: unmelted particle
Length: 0.90 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 15045 pixels^2

Crack 14:
Label: unmelted particle
Length: 0.70 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 14535 pixels^2

Crack 15:
Label: unmelted particle
Length: 0.40 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 5610 pixels^2

Crack 16:
```

```
Label: unmelted particle
Length: 0.70 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 6120 pixels^2

Average area of microcracks: 0.00 cm^2
Average area of unmelted particles: 212.67 cm^2
Average area of porosities: 2356.20 cm^2

[06/16 19:11:17 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: porosity
Length: 1.40 cm
Width: 1.50 cm
Depth: 0.10 cm
Volume: 0.21 cc
Area: 44370 pixels^2

Crack 2:
Label: porosity
Length: 3.20 cm
Width: 1.10 cm
Depth: 0.10 cm
Volume: 0.35 cc
Area: 76500 pixels^2

Crack 3:
Label: porosity
Length: 1.10 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.09 cc
Area: 23205 pixels^2

Crack 4:
Label: unmelted particle
Length: 2.10 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.21 cc
Area: 48960 pixels^2

Crack 5:
Label: unmelted particle
Length: 0.40 cm
```

```
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.01 cc
Area: 3825 pixels^2

Crack 6:
Label: porosity
Length: 1.10 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.08 cc
Area: 18615 pixels^2

Crack 7:
Label: unmelted particle
Length: 0.40 cm
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.01 cc
Area: 3825 pixels^2

Crack 8:
Label: unmelted particle
Length: 0.80 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 11985 pixels^2

Crack 9:
Label: unmelted particle
Length: 0.40 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 9435 pixels^2

Crack 10:
Label: unmelted particle
Length: 0.50 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 6120 pixels^2

Crack 11:
Label: unmelted particle
Length: 0.50 cm
Width: 0.40 cm
Depth: 0.10 cm
```

```
Volume: 0.02 cc
Area: 5610 pixels^2

Crack 12:
Label: unmelted particle
Length: 0.70 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 8160 pixels^2

Crack 13:
Label: unmelted particle
Length: 0.90 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 15300 pixels^2

Crack 14:
Label: unmelted particle
Length: 0.50 cm
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 5355 pixels^2

Crack 15:
Label: unmelted particle
Length: 2.40 cm
Width: 1.30 cm
Depth: 0.10 cm
Volume: 0.31 cc
Area: 65280 pixels^2

Crack 16:
Label: unmelted particle
Length: 1.70 cm
Width: 1.10 cm
Depth: 0.10 cm
Volume: 0.19 cc
Area: 39780 pixels^2

Crack 17:
Label: unmelted particle
Length: 1.10 cm
Width: 1.30 cm
Depth: 0.10 cm
Volume: 0.14 cc
Area: 30600 pixels^2
```

```
Crack 18:
Label: unmelted particle
Length: 0.60 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 8670 pixels^2

Crack 19:
Label: unmelted particle
Length: 2.70 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.14 cc
Area: 29070 pixels^2

Crack 20:
Label: unmelted particle
Length: 0.40 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 6885 pixels^2

Crack 21:
Label: unmelted particle
Length: 0.40 cm
Width: 0.20 cm
Depth: 0.10 cm
Volume: 0.01 cc
Area: 2550 pixels^2

Crack 22:
Label: unmelted particle
Length: 0.30 cm
Width: 0.20 cm
Depth: 0.10 cm
Volume: 0.01 cc
Area: 2040 pixels^2

Crack 23:
Label: unmelted particle
Length: 0.60 cm
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 5610 pixels^2

Crack 24:
```

```
Label: unmelted particle
Length: 0.70 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 11730 pixels^2

Crack 25:
Label: microcrack
Length: 1.50 cm
Width: 1.60 cm
Depth: 0.10 cm
Volume: 0.24 cc
Area: 49470 pixels^2

Crack 26:
Label: microcrack
Length: 1.60 cm
Width: 1.30 cm
Depth: 0.10 cm
Volume: 0.21 cc
Area: 38505 pixels^2

Crack 27:
Label: unmelted particle
Length: 2.00 cm
Width: 1.30 cm
Depth: 0.10 cm
Volume: 0.26 cc
Area: 59415 pixels^2

Crack 28:
Label: unmelted particle
Length: 0.80 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 11220 pixels^2

Crack 29:
Label: unmelted particle
Length: 0.50 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 7395 pixels^2

Crack 30:
Label: unmelted particle
Length: 0.80 cm
```

```
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 9180 pixels^2

Average area of microcracks: 439.88 cm^2
Average area of unmelted particles: 170.00 cm^2
Average area of porosities: 406.73 cm^2

[06/16 19:11:18 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: porosity
Length: 1.80 cm
Width: 1.20 cm
Depth: 0.10 cm
Volume: 0.22 cc
Area: 48195 pixels^2

Crack 2:
Label: porosity
Length: 0.80 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 11220 pixels^2

Crack 3:
Label: unmelted particle
Length: 0.80 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 14790 pixels^2

Crack 4:
Label: unmelted particle
Length: 1.00 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.10 cc
Area: 20400 pixels^2

Crack 5:
Label: unmelted particle
Length: 0.70 cm
Width: 0.40 cm
Depth: 0.10 cm
```

```
Volume: 0.03 cc
Area: 8415 pixels^2

Crack 6:
Label: unmelted particle
Length: 0.40 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 4335 pixels^2

Crack 7:
Label: unmelted particle
Length: 0.80 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 9180 pixels^2

Crack 8:
Label: porosity
Length: 2.70 cm
Width: 1.10 cm
Depth: 0.10 cm
Volume: 0.30 cc
Area: 51255 pixels^2

Crack 9:
Label: unmelted particle
Length: 1.50 cm
Width: 2.90 cm
Depth: 0.10 cm
Volume: 0.44 cc
Area: 42075 pixels^2

Crack 10:
Label: unmelted particle
Length: 0.50 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 6885 pixels^2

Crack 11:
Label: unmelted particle
Length: 0.60 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 7140 pixels^2
```

```
Crack 12:
Label: unmelted particle
Length: 0.50 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 6885 pixels^2

Crack 13:
Label: unmelted particle
Length: 0.60 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 10455 pixels^2

Average area of microcracks: 0.00 cm^2
Average area of unmelted particles: 130.56 cm^2
Average area of porosities: 368.90 cm^2

[06/16 19:11:18 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: porosity
Length: 4.20 cm
Width: 4.50 cm
Depth: 0.10 cm
Volume: 1.89 cc
Area: 387855 pixels^2

Crack 2:
Label: porosity
Length: 1.20 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.11 cc
Area: 26265 pixels^2

Crack 3:
Label: unmelted particle
Length: 1.40 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.13 cc
Area: 27285 pixels^2

Crack 4:
```

```
Label: unmelted particle
Length: 0.50 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 10200 pixels^2

Crack 5:
Label: unmelted particle
Length: 2.20 cm
Width: 1.50 cm
Depth: 0.10 cm
Volume: 0.33 cc
Area: 51765 pixels^2

Crack 6:
Label: unmelted particle
Length: 0.50 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 5865 pixels^2

Crack 7:
Label: unmelted particle
Length: 0.40 cm
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.01 cc
Area: 3570 pixels^2

Crack 8:
Label: unmelted particle
Length: 1.00 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 13005 pixels^2

Crack 9:
Label: unmelted particle
Length: 0.70 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 9180 pixels^2

Crack 10:
Label: unmelted particle
Length: 0.50 cm
```

```
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 6375 pixels^2

Crack 11:
Label: unmelted particle
Length: 1.10 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.08 cc
Area: 16830 pixels^2

Crack 12:
Label: unmelted particle
Length: 1.10 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.07 cc
Area: 17850 pixels^2

Crack 13:
Label: unmelted particle
Length: 0.70 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 7140 pixels^2

Crack 14:
Label: unmelted particle
Length: 0.60 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 8160 pixels^2

Crack 15:
Label: unmelted particle
Length: 0.50 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 7395 pixels^2

Crack 16:
Label: unmelted particle
Length: 0.50 cm
Width: 0.20 cm
Depth: 0.10 cm
```

```
Volume: 0.01 cc
Area: 3570 pixels^2

Crack 17:
Label: unmelted particle
Length: 0.60 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 7140 pixels^2

Crack 18:
Label: unmelted particle
Length: 0.90 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.07 cc
Area: 17340 pixels^2

Average area of microcracks: 0.00 cm^2
Average area of unmelted particles: 132.92 cm^2
Average area of porosities: 2070.60 cm^2

[06/16 19:11:19 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: microcrack
Length: 8.10 cm
Width: 12.00 cm
Depth: 0.10 cm
Volume: 9.72 cc
Area: 514845 pixels^2

Crack 2:
Label: unmelted particle
Length: 1.60 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.16 cc
Area: 33660 pixels^2

Crack 3:
Label: unmelted particle
Length: 3.00 cm
Width: 2.10 cm
Depth: 0.10 cm
Volume: 0.63 cc
Area: 118065 pixels^2
```

```
Crack 4:
Label: unmelted particle
Length: 0.60 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 9180 pixels^2

Crack 5:
Label: unmelted particle
Length: 2.20 cm
Width: 1.70 cm
Depth: 0.10 cm
Volume: 0.37 cc
Area: 61455 pixels^2

Crack 6:
Label: unmelted particle
Length: 0.90 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.08 cc
Area: 16575 pixels^2

Crack 7:
Label: unmelted particle
Length: 2.50 cm
Width: 2.50 cm
Depth: 0.10 cm
Volume: 0.62 cc
Area: 99195 pixels^2

Crack 8:
Label: porosity
Length: 1.20 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.11 cc
Area: 25755 pixels^2

Crack 9:
Label: porosity
Length: 0.70 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 11985 pixels^2

Crack 10:
```

```
Label: unmelted particle
Length: 0.80 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 14280 pixels^2

Crack 11:
Label: unmelted particle
Length: 0.90 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 10710 pixels^2

Crack 12:
Label: unmelted particle
Length: 0.40 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 6630 pixels^2

Crack 13:
Label: porosity
Length: 0.80 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 11985 pixels^2

Crack 14:
Label: microcrack
Length: 0.50 cm
Width: 1.10 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 14535 pixels^2

Crack 15:
Label: unmelted particle
Length: 0.70 cm
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 5100 pixels^2

Average area of microcracks: 2646.90 cm^2
Average area of unmelted particles: 374.85 cm^2
Average area of porosities: 165.75 cm^2
```

```
[06/16 19:11:20 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: unmelted particle
Length: 2.30 cm
Width: 2.00 cm
Depth: 0.10 cm
Volume: 0.46 cc
Area: 85170 pixels^2

Crack 2:
Label: unmelted particle
Length: 1.40 cm
Width: 1.20 cm
Depth: 0.10 cm
Volume: 0.17 cc
Area: 33405 pixels^2

Crack 3:
Label: unmelted particle
Length: 1.10 cm
Width: 1.30 cm
Depth: 0.10 cm
Volume: 0.14 cc
Area: 28050 pixels^2

Crack 4:
Label: unmelted particle
Length: 0.80 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 11985 pixels^2

Crack 5:
Label: unmelted particle
Length: 0.90 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.09 cc
Area: 21930 pixels^2

Crack 6:
Label: unmelted particle
Length: 1.00 cm
Width: 0.60 cm
Depth: 0.10 cm
```

```
Volume: 0.06 cc
Area: 14025 pixels^2

Crack 7:
Label: unmelted particle
Length: 0.60 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 7140 pixels^2

Crack 8:
Label: unmelted particle
Length: 0.60 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 4335 pixels^2

Crack 9:
Label: unmelted particle
Length: 0.60 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 6885 pixels^2

Crack 10:
Label: unmelted particle
Length: 1.10 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.08 cc
Area: 19890 pixels^2

Crack 11:
Label: unmelted particle
Length: 1.60 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.13 cc
Area: 26010 pixels^2

Crack 12:
Label: unmelted particle
Length: 0.40 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 5355 pixels^2
```

```
Crack 13:
Label: unmelted particle
Length: 0.50 cm
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 4590 pixels^2

Crack 14:
Label: unmelted particle
Length: 0.60 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 8670 pixels^2

Crack 15:
Label: unmelted particle
Length: 0.40 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 7905 pixels^2

Average area of microcracks: 0.00 cm^2
Average area of unmelted particles: 190.23 cm^2
Average area of porosities: 0.00 cm^2

[06/16 19:11:22 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: unmelted particle
Length: 3.60 cm
Width: 2.10 cm
Depth: 0.10 cm
Volume: 0.76 cc
Area: 141780 pixels^2

Crack 2:
Label: unmelted particle
Length: 4.10 cm
Width: 2.70 cm
Depth: 0.10 cm
Volume: 1.11 cc
Area: 222360 pixels^2

Crack 3:
```

```
Label: porosity
Length: 2.20 cm
Width: 1.90 cm
Depth: 0.10 cm
Volume: 0.42 cc
Area: 84405 pixels^2

Crack 4:
Label: unmelted particle
Length: 0.80 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 11220 pixels^2

Crack 5:
Label: unmelted particle
Length: 1.10 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.07 cc
Area: 13770 pixels^2

Crack 6:
Label: unmelted particle
Length: 0.70 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 13260 pixels^2

Crack 7:
Label: unmelted particle
Length: 0.90 cm
Width: 1.20 cm
Depth: 0.10 cm
Volume: 0.11 cc
Area: 23970 pixels^2

Crack 8:
Label: unmelted particle
Length: 0.90 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.08 cc
Area: 17595 pixels^2

Crack 9:
Label: unmelted particle
Length: 0.90 cm
```

```
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.09 cc
Area: 20655 pixels^2

Crack 10:
Label: porosity
Length: 1.90 cm
Width: 1.30 cm
Depth: 0.10 cm
Volume: 0.25 cc
Area: 57375 pixels^2

Crack 11:
Label: unmelted particle
Length: 2.10 cm
Width: 1.50 cm
Depth: 0.10 cm
Volume: 0.32 cc
Area: 61200 pixels^2

Crack 12:
Label: unmelted particle
Length: 0.70 cm
Width: 1.20 cm
Depth: 0.10 cm
Volume: 0.08 cc
Area: 20145 pixels^2

Crack 13:
Label: unmelted particle
Length: 1.00 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.07 cc
Area: 16575 pixels^2

Crack 14:
Label: unmelted particle
Length: 0.70 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 10200 pixels^2

Crack 15:
Label: unmelted particle
Length: 0.60 cm
Width: 0.40 cm
Depth: 0.10 cm
```

```
Volume: 0.02 cc
Area: 6630 pixels^2

Crack 16:
Label: unmelted particle
Length: 0.40 cm
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.01 cc
Area: 3570 pixels^2

Average area of microcracks: 0.00 cm^2
Average area of unmelted particles: 416.38 cm^2
Average area of porosities: 708.90 cm^2

[06/16 19:11:23 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: unmelted particle
Length: 0.80 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.07 cc
Area: 17340 pixels^2

Crack 2:
Label: unmelted particle
Length: 0.50 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 7650 pixels^2

Crack 3:
Label: porosity
Length: 0.70 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 7905 pixels^2

Crack 4:
Label: unmelted particle
Length: 0.60 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 7140 pixels^2
```

```
Crack 5:
Label: unmelted particle
Length: 0.50 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 5610 pixels^2

Crack 6:
Label: unmelted particle
Length: 0.60 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 7650 pixels^2

Average area of microcracks: 0.00 cm^2
Average area of unmelted particles: 90.78 cm^2
Average area of porosities: 79.05 cm^2

[06/16 19:11:24 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: unmelted particle
Length: 1.40 cm
Width: 1.40 cm
Depth: 0.10 cm
Volume: 0.20 cc
Area: 38505 pixels^2

Crack 2:
Label: porosity
Length: 2.10 cm
Width: 1.80 cm
Depth: 0.10 cm
Volume: 0.38 cc
Area: 71655 pixels^2

Crack 3:
Label: unmelted particle
Length: 1.90 cm
Width: 1.20 cm
Depth: 0.10 cm
Volume: 0.23 cc
Area: 43095 pixels^2

Crack 4:
```

```
Label: unmelted particle
Length: 2.50 cm
Width: 1.60 cm
Depth: 0.10 cm
Volume: 0.40 cc
Area: 80070 pixels^2

Crack 5:
Label: unmelted particle
Length: 1.40 cm
Width: 1.30 cm
Depth: 0.10 cm
Volume: 0.18 cc
Area: 35445 pixels^2

Crack 6:
Label: unmelted particle
Length: 0.90 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.07 cc
Area: 14280 pixels^2

Crack 7:
Label: unmelted particle
Length: 1.30 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.13 cc
Area: 23205 pixels^2

Crack 8:
Label: unmelted particle
Length: 0.90 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 11730 pixels^2

Crack 9:
Label: unmelted particle
Length: 1.40 cm
Width: 1.50 cm
Depth: 0.10 cm
Volume: 0.21 cc
Area: 34680 pixels^2

Crack 10:
Label: unmelted particle
Length: 1.70 cm
```

```
Width: 1.10 cm
Depth: 0.10 cm
Volume: 0.19 cc
Area: 28050 pixels^2

Crack 11:
Label: unmelted particle
Length: 0.70 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 7140 pixels^2

Crack 12:
Label: unmelted particle
Length: 1.20 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.10 cc
Area: 21165 pixels^2

Crack 13:
Label: unmelted particle
Length: 0.60 cm
Width: 1.30 cm
Depth: 0.10 cm
Volume: 0.08 cc
Area: 15555 pixels^2

Crack 14:
Label: unmelted particle
Length: 1.00 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.08 cc
Area: 16065 pixels^2

Crack 15:
Label: unmelted particle
Length: 0.60 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 8925 pixels^2

Crack 16:
Label: unmelted particle
Length: 1.10 cm
Width: 1.00 cm
Depth: 0.10 cm
```

```
Volume: 0.11 cc
Area: 23205 pixels^2

Crack 17:
Label: unmelted particle
Length: 1.20 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.12 cc
Area: 29070 pixels^2

Crack 18:
Label: unmelted particle
Length: 0.50 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 8415 pixels^2

Crack 19:
Label: unmelted particle
Length: 0.70 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 8160 pixels^2

Crack 20:
Label: unmelted particle
Length: 1.00 cm
Width: 1.10 cm
Depth: 0.10 cm
Volume: 0.11 cc
Area: 24735 pixels^2

Crack 21:
Label: unmelted particle
Length: 2.50 cm
Width: 1.30 cm
Depth: 0.10 cm
Volume: 0.33 cc
Area: 39525 pixels^2

Crack 22:
Label: unmelted particle
Length: 0.80 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 10200 pixels^2
```

```
Crack 23:
Label: porosity
Length: 0.40 cm
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.01 cc
Area: 4080 pixels^2

Crack 24:
Label: unmelted particle
Length: 0.40 cm
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.01 cc
Area: 3825 pixels^2

Crack 25:
Label: porosity
Length: 3.80 cm
Width: 1.80 cm
Depth: 0.10 cm
Volume: 0.68 cc
Area: 135915 pixels^2

Crack 26:
Label: porosity
Length: 0.50 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 7395 pixels^2

Crack 27:
Label: unmelted particle
Length: 0.70 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 13005 pixels^2

Crack 28:
Label: unmelted particle
Length: 0.80 cm
Width: 1.10 cm
Depth: 0.10 cm
Volume: 0.09 cc
Area: 17595 pixels^2

Crack 29:
```

```
Label: unmelted particle
Length: 1.10 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.11 cc
Area: 21675 pixels^2

Crack 30:
Label: unmelted particle
Length: 0.70 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 7905 pixels^2

Crack 31:
Label: unmelted particle
Length: 1.00 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.08 cc
Area: 16575 pixels^2

Crack 32:
Label: unmelted particle
Length: 1.20 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.11 cc
Area: 23970 pixels^2

Crack 33:
Label: unmelted particle
Length: 0.90 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 11985 pixels^2

Crack 34:
Label: unmelted particle
Length: 1.00 cm
Width: 1.20 cm
Depth: 0.10 cm
Volume: 0.12 cc
Area: 22440 pixels^2

Crack 35:
Label: unmelted particle
Length: 1.10 cm
```

```
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.11 cc
Area: 27285 pixels^2

Crack 36:
Label: unmelted particle
Length: 1.20 cm
Width: 1.40 cm
Depth: 0.10 cm
Volume: 0.17 cc
Area: 35445 pixels^2

Crack 37:
Label: unmelted particle
Length: 0.40 cm
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.01 cc
Area: 4590 pixels^2

Crack 38:
Label: unmelted particle
Length: 0.60 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 7140 pixels^2

Crack 39:
Label: unmelted particle
Length: 0.60 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 13515 pixels^2

Crack 40:
Label: unmelted particle
Length: 0.80 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 7395 pixels^2

Crack 41:
Label: unmelted particle
Length: 0.90 cm
Width: 0.60 cm
Depth: 0.10 cm
```

```
Volume: 0.05 cc
Area: 11730 pixels^2

Crack 42:
Label: unmelted particle
Length: 0.60 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 6375 pixels^2

Crack 43:
Label: unmelted particle
Length: 0.90 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 14025 pixels^2

Crack 44:
Label: unmelted particle
Length: 6.80 cm
Width: 1.70 cm
Depth: 0.10 cm
Volume: 1.16 cc
Area: 121125 pixels^2

Crack 45:
Label: unmelted particle
Length: 2.80 cm
Width: 1.50 cm
Depth: 0.10 cm
Volume: 0.42 cc
Area: 42330 pixels^2

Crack 46:
Label: unmelted particle
Length: 0.70 cm
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 6120 pixels^2

Crack 47:
Label: unmelted particle
Length: 0.30 cm
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.01 cc
Area: 3315 pixels^2
```

```
Crack 48:
Label: unmelted particle
Length: 4.50 cm
Width: 1.70 cm
Depth: 0.10 cm
Volume: 0.77 cc
Area: 59160 pixels^2

Crack 49:
Label: unmelted particle
Length: 0.30 cm
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.01 cc
Area: 3060 pixels^2

Crack 50:
Label: unmelted particle
Length: 0.50 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 11730 pixels^2

Crack 51:
Label: unmelted particle
Length: 0.80 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 9435 pixels^2

Average area of microcracks: 0.00 cm^2
Average area of unmelted particles: 222.12 cm^2
Average area of porosities: 547.61 cm^2

[06/16 19:11:25 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: microcrack
Length: 1.00 cm
Width: 3.20 cm
Depth: 0.10 cm
Volume: 0.32 cc
Area: 65790 pixels^2

Crack 2:
```

```
Label: porosity
Length: 0.40 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 4590 pixels^2

Crack 3:
Label: unmelted particle
Length: 0.50 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 4845 pixels^2

Crack 4:
Label: unmelted particle
Length: 0.70 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 9945 pixels^2

Crack 5:
Label: unmelted particle
Length: 1.00 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.07 cc
Area: 13770 pixels^2

Crack 6:
Label: unmelted particle
Length: 0.60 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 7905 pixels^2

Crack 7:
Label: unmelted particle
Length: 0.80 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.07 cc
Area: 16575 pixels^2

Crack 8:
Label: unmelted particle
Length: 1.20 cm
```

```
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.10 cc
Area: 17595 pixels^2

Crack 9:
Label: unmelted particle
Length: 0.50 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 6375 pixels^2

Crack 10:
Label: unmelted particle
Length: 0.40 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 5100 pixels^2

Crack 11:
Label: unmelted particle
Length: 1.40 cm
Width: 1.60 cm
Depth: 0.10 cm
Volume: 0.22 cc
Area: 39270 pixels^2

Crack 12:
Label: unmelted particle
Length: 0.80 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 10200 pixels^2

Crack 13:
Label: unmelted particle
Length: 0.50 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 6120 pixels^2

Crack 14:
Label: porosity
Length: 1.40 cm
Width: 1.00 cm
Depth: 0.10 cm
```

```
Volume: 0.14 cc
Area: 29325 pixels^2

Crack 15:
Label: unmelted particle
Length: 1.60 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.11 cc
Area: 21420 pixels^2

Crack 16:
Label: unmelted particle
Length: 1.00 cm
Width: 1.20 cm
Depth: 0.10 cm
Volume: 0.12 cc
Area: 27795 pixels^2

Crack 17:
Label: unmelted particle
Length: 0.90 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 11985 pixels^2

Crack 18:
Label: unmelted particle
Length: 1.50 cm
Width: 1.80 cm
Depth: 0.10 cm
Volume: 0.27 cc
Area: 55845 pixels^2

Crack 19:
Label: microcrack
Length: 2.30 cm
Width: 4.00 cm
Depth: 0.10 cm
Volume: 0.92 cc
Area: 167535 pixels^2

Crack 20:
Label: porosity
Length: 1.10 cm
Width: 1.50 cm
Depth: 0.10 cm
Volume: 0.17 cc
Area: 29070 pixels^2
```

```
Crack 21:
Label: unmelted particle
Length: 0.60 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 6630 pixels^2

Crack 22:
Label: unmelted particle
Length: 0.50 cm
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 5610 pixels^2

Crack 23:
Label: unmelted particle
Length: 0.80 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 10455 pixels^2

Average area of microcracks: 1166.63 cm^2
Average area of unmelted particles: 154.13 cm^2
Average area of porosities: 209.95 cm^2

[06/16 19:11:26 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: porosity
Length: 1.50 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.15 cc
Area: 29835 pixels^2

Crack 2:
Label: unmelted particle
Length: 1.60 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.16 cc
Area: 34935 pixels^2

Crack 3:
```

```
Label: unmelted particle
Length: 1.40 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.13 cc
Area: 27540 pixels^2

Crack 4:
Label: porosity
Length: 4.30 cm
Width: 4.50 cm
Depth: 0.10 cm
Volume: 1.93 cc
Area: 129540 pixels^2

Crack 5:
Label: unmelted particle
Length: 2.60 cm
Width: 1.80 cm
Depth: 0.10 cm
Volume: 0.47 cc
Area: 66300 pixels^2

Crack 6:
Label: unmelted particle
Length: 1.20 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.10 cc
Area: 21675 pixels^2

Crack 7:
Label: unmelted particle
Length: 1.10 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.10 cc
Area: 21930 pixels^2

Crack 8:
Label: unmelted particle
Length: 1.00 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 11985 pixels^2

Crack 9:
Label: unmelted particle
Length: 0.70 cm
```

```
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 14790 pixels^2

Crack 10:
Label: unmelted particle
Length: 1.60 cm
Width: 1.70 cm
Depth: 0.10 cm
Volume: 0.27 cc
Area: 54060 pixels^2

Crack 11:
Label: unmelted particle
Length: 1.10 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.10 cc
Area: 17595 pixels^2

Crack 12:
Label: unmelted particle
Length: 1.60 cm
Width: 1.30 cm
Depth: 0.10 cm
Volume: 0.21 cc
Area: 39270 pixels^2

Crack 13:
Label: unmelted particle
Length: 0.90 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 15555 pixels^2

Crack 14:
Label: unmelted particle
Length: 0.80 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 10455 pixels^2

Crack 15:
Label: unmelted particle
Length: 0.60 cm
Width: 0.40 cm
Depth: 0.10 cm
```

```
Volume: 0.02 cc
Area: 7395 pixels^2

Crack 16:
Label: unmelted particle
Length: 0.50 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 5100 pixels^2

Average area of microcracks: 0.00 cm^2
Average area of unmelted particles: 248.99 cm^2
Average area of porosities: 796.88 cm^2

[06/16 19:11:26 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: unmelted particle
Length: 2.00 cm
Width: 1.50 cm
Depth: 0.10 cm
Volume: 0.30 cc
Area: 76245 pixels^2

Crack 2:
Label: unmelted particle
Length: 1.60 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.16 cc
Area: 38760 pixels^2

Crack 3:
Label: unmelted particle
Length: 1.00 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.07 cc
Area: 13515 pixels^2

Crack 4:
Label: unmelted particle
Length: 0.50 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 7650 pixels^2
```

```
Crack 5:
Label: unmelted particle
Length: 0.80 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 16320 pixels^2

Crack 6:
Label: unmelted particle
Length: 1.50 cm
Width: 1.40 cm
Depth: 0.10 cm
Volume: 0.21 cc
Area: 44880 pixels^2

Crack 7:
Label: unmelted particle
Length: 1.60 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.16 cc
Area: 31620 pixels^2

Crack 8:
Label: unmelted particle
Length: 1.40 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.14 cc
Area: 26520 pixels^2

Crack 9:
Label: unmelted particle
Length: 1.40 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.10 cc
Area: 25755 pixels^2

Crack 10:
Label: unmelted particle
Length: 0.60 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 8160 pixels^2

Crack 11:
```

```
Label: unmelted particle
Length: 0.60 cm
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 5100 pixels^2

Crack 12:
Label: unmelted particle
Length: 0.40 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 4080 pixels^2

Crack 13:
Label: unmelted particle
Length: 0.20 cm
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.01 cc
Area: 2805 pixels^2

Crack 14:
Label: unmelted particle
Length: 0.40 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 4845 pixels^2

Crack 15:
Label: unmelted particle
Length: 1.80 cm
Width: 1.10 cm
Depth: 0.10 cm
Volume: 0.20 cc
Area: 39525 pixels^2

Crack 16:
Label: unmelted particle
Length: 0.70 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 9945 pixels^2

Crack 17:
Label: unmelted particle
Length: 0.60 cm
```

```
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 7650 pixels^2

Crack 18:
Label: unmelted particle
Length: 0.60 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 7140 pixels^2

Crack 19:
Label: unmelted particle
Length: 0.50 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 8670 pixels^2

Average area of microcracks: 0.00 cm^2
Average area of unmelted particles: 199.57 cm^2
Average area of porosities: 0.00 cm^2

[06/16 19:11:27 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: porosity
Length: 3.10 cm
Width: 2.00 cm
Depth: 0.10 cm
Volume: 0.62 cc
Area: 131835 pixels^2

Crack 2:
Label: unmelted particle
Length: 1.50 cm
Width: 1.30 cm
Depth: 0.10 cm
Volume: 0.20 cc
Area: 40290 pixels^2

Crack 3:
Label: unmelted particle
Length: 2.00 cm
Width: 1.50 cm
Depth: 0.10 cm
```

```
Volume: 0.30 cc
Area: 54060 pixels^2

Crack 4:
Label: unmelted particle
Length: 1.60 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.16 cc
Area: 31365 pixels^2

Crack 5:
Label: unmelted particle
Length: 1.50 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.15 cc
Area: 30600 pixels^2

Crack 6:
Label: unmelted particle
Length: 1.00 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.09 cc
Area: 22185 pixels^2

Crack 7:
Label: unmelted particle
Length: 2.40 cm
Width: 2.30 cm
Depth: 0.10 cm
Volume: 0.55 cc
Area: 107610 pixels^2

Crack 8:
Label: unmelted particle
Length: 1.50 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.15 cc
Area: 28815 pixels^2

Crack 9:
Label: unmelted particle
Length: 0.60 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 11220 pixels^2
```

```
Crack 10:
Label: unmelted particle
Length: 0.70 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 8415 pixels^2

Crack 11:
Label: unmelted particle
Length: 1.60 cm
Width: 1.10 cm
Depth: 0.10 cm
Volume: 0.18 cc
Area: 35445 pixels^2

Crack 12:
Label: unmelted particle
Length: 1.00 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 16065 pixels^2

Crack 13:
Label: unmelted particle
Length: 0.50 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 6120 pixels^2

Average area of microcracks: 0.00 cm^2
Average area of unmelted particles: 326.83 cm^2
Average area of porosities: 1318.35 cm^2

[06/16 19:11:28 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: porosity
Length: 4.20 cm
Width: 2.80 cm
Depth: 0.10 cm
Volume: 1.18 cc
Area: 244800 pixels^2

Crack 2:
```

```
Label: porosity
Length: 1.20 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.12 cc
Area: 25755 pixels^2

Crack 3:
Label: unmelted particle
Length: 1.70 cm
Width: 1.30 cm
Depth: 0.10 cm
Volume: 0.22 cc
Area: 50745 pixels^2

Crack 4:
Label: unmelted particle
Length: 0.90 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 14025 pixels^2

Crack 5:
Label: unmelted particle
Length: 1.20 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.10 cc
Area: 21675 pixels^2

Crack 6:
Label: unmelted particle
Length: 0.80 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 10965 pixels^2

Crack 7:
Label: unmelted particle
Length: 0.90 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 14790 pixels^2

Crack 8:
Label: unmelted particle
Length: 0.80 cm
```

```
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 10200 pixels^2

Crack 9:
Label: unmelted particle
Length: 1.30 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.09 cc
Area: 23970 pixels^2

Crack 10:
Label: unmelted particle
Length: 2.50 cm
Width: 1.30 cm
Depth: 0.10 cm
Volume: 0.33 cc
Area: 59160 pixels^2

Crack 11:
Label: unmelted particle
Length: 2.00 cm
Width: 1.70 cm
Depth: 0.10 cm
Volume: 0.34 cc
Area: 70380 pixels^2

Crack 12:
Label: unmelted particle
Length: 0.70 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 13515 pixels^2

Crack 13:
Label: unmelted particle
Length: 0.50 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 6630 pixels^2

Average area of microcracks: 0.00 cm^2
Average area of unmelted particles: 269.14 cm^2
Average area of porosities: 1352.78 cm^2

[06/16 19:11:29 d2.checkpoint.detection_checkpoint]:
```

```
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: unmelted particle
Length: 3.70 cm
Width: 3.70 cm
Depth: 0.10 cm
Volume: 1.37 cc
Area: 250920 pixels^2

Crack 2:
Label: unmelted particle
Length: 0.90 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.07 cc
Area: 12240 pixels^2

Crack 3:
Label: unmelted particle
Length: 2.20 cm
Width: 1.40 cm
Depth: 0.10 cm
Volume: 0.31 cc
Area: 51255 pixels^2

Crack 4:
Label: unmelted particle
Length: 2.10 cm
Width: 1.30 cm
Depth: 0.10 cm
Volume: 0.27 cc
Area: 60945 pixels^2

Crack 5:
Label: unmelted particle
Length: 0.90 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.08 cc
Area: 14535 pixels^2

Crack 6:
Label: unmelted particle
Length: 0.60 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 12495 pixels^2
```

```
Crack 7:
Label: unmelted particle
Length: 0.60 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 10200 pixels^2

Crack 8:
Label: unmelted particle
Length: 0.50 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 6120 pixels^2

Crack 9:
Label: unmelted particle
Length: 0.40 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 4080 pixels^2

Crack 10:
Label: unmelted particle
Length: 0.50 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 8670 pixels^2

Crack 11:
Label: unmelted particle
Length: 0.70 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 13260 pixels^2

Crack 12:
Label: unmelted particle
Length: 0.60 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 6375 pixels^2

Crack 13:
```

```
Label: unmelted particle
Length: 0.70 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 9180 pixels^2

Average area of microcracks: 0.00 cm^2
Average area of unmelted particles: 354.06 cm^2
Average area of porosities: 0.00 cm^2

[06/16 19:11:30 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: unmelted particle
Length: 2.90 cm
Width: 1.80 cm
Depth: 0.10 cm
Volume: 0.52 cc
Area: 102255 pixels^2

Crack 2:
Label: unmelted particle
Length: 0.90 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 13005 pixels^2

Crack 3:
Label: porosity
Length: 0.70 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 11220 pixels^2

Crack 4:
Label: unmelted particle
Length: 0.90 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 10965 pixels^2

Crack 5:
Label: unmelted particle
Length: 1.60 cm
```

```
Width: 1.30 cm
Depth: 0.10 cm
Volume: 0.21 cc
Area: 45135 pixels^2

Crack 6:
Label: unmelted particle
Length: 0.50 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 7140 pixels^2

Crack 7:
Label: unmelted particle
Length: 1.10 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.11 cc
Area: 26265 pixels^2

Crack 8:
Label: porosity
Length: 0.70 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 6885 pixels^2

Crack 9:
Label: unmelted particle
Length: 0.70 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 9690 pixels^2

Crack 10:
Label: unmelted particle
Length: 1.40 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.10 cc
Area: 20145 pixels^2

Crack 11:
Label: unmelted particle
Length: 1.00 cm
Width: 0.90 cm
Depth: 0.10 cm
```

```
Volume: 0.09 cc
Area: 17850 pixels^2

Crack 12:
Label: unmelted particle
Length: 1.00 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.10 cc
Area: 25500 pixels^2

Crack 13:
Label: unmelted particle
Length: 1.10 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.07 cc
Area: 17850 pixels^2

Crack 14:
Label: porosity
Length: 0.80 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 13770 pixels^2

Crack 15:
Label: unmelted particle
Length: 1.10 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.08 cc
Area: 14790 pixels^2

Crack 16:
Label: unmelted particle
Length: 2.10 cm
Width: 1.10 cm
Depth: 0.10 cm
Volume: 0.23 cc
Area: 46665 pixels^2

Crack 17:
Label: unmelted particle
Length: 0.80 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.07 cc
Area: 14025 pixels^2
```

```
Crack 18:
Label: unmelted particle
Length: 0.60 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 11985 pixels^2

Crack 19:
Label: unmelted particle
Length: 0.60 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 7140 pixels^2

Crack 20:
Label: unmelted particle
Length: 0.60 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 8415 pixels^2

Average area of microcracks: 0.00 cm^2
Average area of unmelted particles: 234.60 cm^2
Average area of porosities: 106.25 cm^2

[06/16 19:11:31 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: porosity
Length: 4.40 cm
Width: 3.30 cm
Depth: 0.10 cm
Volume: 1.45 cc
Area: 302685 pixels^2

Crack 2:
Label: unmelted particle
Length: 1.20 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.11 cc
Area: 22440 pixels^2

Crack 3:
```

```
Label: porosity
Length: 4.20 cm
Width: 1.40 cm
Depth: 0.10 cm
Volume: 0.59 cc
Area: 84405 pixels^2

Crack 4:
Label: unmelted particle
Length: 0.40 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 7140 pixels^2

Crack 5:
Label: unmelted particle
Length: 0.70 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 9945 pixels^2

Crack 6:
Label: unmelted particle
Length: 1.10 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.08 cc
Area: 19125 pixels^2

Crack 7:
Label: unmelted particle
Length: 0.90 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 11220 pixels^2

Crack 8:
Label: unmelted particle
Length: 0.90 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 11475 pixels^2

Average area of microcracks: 0.00 cm^2
Average area of unmelted particles: 135.58 cm^2
Average area of porosities: 1935.45 cm^2
```

```
[06/16 19:11:32 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: unmelted particle
Length: 3.20 cm
Width: 2.00 cm
Depth: 0.10 cm
Volume: 0.64 cc
Area: 117300 pixels^2

Crack 2:
Label: unmelted particle
Length: 1.30 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.13 cc
Area: 30855 pixels^2

Crack 3:
Label: unmelted particle
Length: 1.20 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.11 cc
Area: 24735 pixels^2

Crack 4:
Label: unmelted particle
Length: 1.70 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.15 cc
Area: 34680 pixels^2

Crack 5:
Label: unmelted particle
Length: 0.80 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 11985 pixels^2

Crack 6:
Label: porosity
Length: 3.80 cm
Width: 3.10 cm
Depth: 0.10 cm
```

```
Volume: 1.18 cc
Area: 138975 pixels^2

Crack 7:
Label: unmelted particle
Length: 1.10 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.09 cc
Area: 20400 pixels^2

Crack 8:
Label: unmelted particle
Length: 0.70 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 9945 pixels^2

Crack 9:
Label: unmelted particle
Length: 0.80 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 11475 pixels^2

Crack 10:
Label: unmelted particle
Length: 2.90 cm
Width: 1.50 cm
Depth: 0.10 cm
Volume: 0.44 cc
Area: 92820 pixels^2

Crack 11:
Label: unmelted particle
Length: 1.60 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.14 cc
Area: 36720 pixels^2

Crack 12:
Label: unmelted particle
Length: 0.70 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 7395 pixels^2
```

```
Crack 13:
Label: unmelted particle
Length: 0.40 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 5865 pixels^2

Crack 14:
Label: unmelted particle
Length: 0.80 cm
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 7140 pixels^2

Crack 15:
Label: unmelted particle
Length: 1.40 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.13 cc
Area: 29070 pixels^2

Crack 16:
Label: unmelted particle
Length: 1.50 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.14 cc
Area: 32385 pixels^2

Crack 17:
Label: unmelted particle
Length: 0.80 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.08 cc
Area: 19125 pixels^2

Crack 18:
Label: unmelted particle
Length: 0.80 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 11985 pixels^2

Crack 19:
```

```
Label: unmelted particle
Length: 0.50 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 7905 pixels^2

Crack 20:
Label: unmelted particle
Length: 0.60 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 9945 pixels^2

Crack 21:
Label: unmelted particle
Length: 1.20 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.07 cc
Area: 18360 pixels^2

Crack 22:
Label: unmelted particle
Length: 0.50 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 7140 pixels^2

Crack 23:
Label: unmelted particle
Length: 1.30 cm
Width: 1.40 cm
Depth: 0.10 cm
Volume: 0.18 cc
Area: 22950 pixels^2

Crack 24:
Label: unmelted particle
Length: 1.70 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.15 cc
Area: 33660 pixels^2

Average area of microcracks: 0.00 cm^2
Average area of unmelted particles: 262.54 cm^2
Average area of porosities: 1389.75 cm^2
```

```
[06/16 19:11:33 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: unmelted particle
Length: 1.70 cm
Width: 1.30 cm
Depth: 0.10 cm
Volume: 0.22 cc
Area: 43860 pixels^2

Crack 2:
Label: unmelted particle
Length: 1.40 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.14 cc
Area: 36210 pixels^2

Crack 3:
Label: porosity
Length: 1.20 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.10 cc
Area: 21420 pixels^2

Crack 4:
Label: unmelted particle
Length: 0.60 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 10965 pixels^2

Crack 5:
Label: unmelted particle
Length: 1.20 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.08 cc
Area: 21165 pixels^2

Crack 6:
Label: unmelted particle
Length: 0.70 cm
Width: 0.60 cm
Depth: 0.10 cm
```

```
Volume: 0.04 cc
Area: 10965 pixels^2

Crack 7:
Label: unmelted particle
Length: 1.70 cm
Width: 1.20 cm
Depth: 0.10 cm
Volume: 0.20 cc
Area: 39525 pixels^2

Crack 8:
Label: unmelted particle
Length: 1.80 cm
Width: 1.50 cm
Depth: 0.10 cm
Volume: 0.27 cc
Area: 59670 pixels^2

Crack 9:
Label: unmelted particle
Length: 0.60 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 12750 pixels^2

Crack 10:
Label: unmelted particle
Length: 0.70 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 9945 pixels^2

Crack 11:
Label: unmelted particle
Length: 0.90 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 17595 pixels^2

Crack 12:
Label: unmelted particle
Length: 0.70 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 11220 pixels^2
```

```
Crack 13:
Label: unmelted particle
Length: 1.00 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.08 cc
Area: 19635 pixels^2

Crack 14:
Label: unmelted particle
Length: 0.60 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 8925 pixels^2

Crack 15:
Label: unmelted particle
Length: 0.60 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 7650 pixels^2

Crack 16:
Label: unmelted particle
Length: 0.60 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 11220 pixels^2

Crack 17:
Label: porosity
Length: 0.70 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 7905 pixels^2

Crack 18:
Label: unmelted particle
Length: 0.70 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 9945 pixels^2

Crack 19:
```

```
Label: unmelted particle
Length: 0.70 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 8925 pixels^2

Average area of microcracks: 0.00 cm^2
Average area of unmelted particles: 200.10 cm^2
Average area of porosities: 146.63 cm^2

[06/16 19:11:34 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: porosity
Length: 4.80 cm
Width: 4.00 cm
Depth: 0.10 cm
Volume: 1.92 cc
Area: 343230 pixels^2

Crack 2:
Label: unmelted particle
Length: 2.50 cm
Width: 1.30 cm
Depth: 0.10 cm
Volume: 0.33 cc
Area: 67065 pixels^2

Crack 3:
Label: unmelted particle
Length: 2.40 cm
Width: 2.30 cm
Depth: 0.10 cm
Volume: 0.55 cc
Area: 112965 pixels^2

Crack 4:
Label: unmelted particle
Length: 0.80 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 14280 pixels^2

Crack 5:
Label: unmelted particle
Length: 0.60 cm
```

```
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 5865 pixels^2

Crack 6:
Label: unmelted particle
Length: 0.90 cm
Width: 1.10 cm
Depth: 0.10 cm
Volume: 0.10 cc
Area: 9435 pixels^2

Crack 7:
Label: unmelted particle
Length: 0.30 cm
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.01 cc
Area: 4080 pixels^2

Crack 8:
Label: unmelted particle
Length: 3.70 cm
Width: 1.10 cm
Depth: 0.10 cm
Volume: 0.41 cc
Area: 95880 pixels^2

Crack 9:
Label: unmelted particle
Length: 0.70 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 9435 pixels^2

Crack 10:
Label: unmelted particle
Length: 0.50 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 6885 pixels^2

Average area of microcracks: 0.00 cm^2
Average area of unmelted particles: 362.10 cm^2
Average area of porosities: 3432.30 cm^2

[06/16 19:11:35 d2.checkpoint.detection_checkpoint]:
```

```
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: porosity
Length: 9.00 cm
Width: 2.50 cm
Depth: 0.10 cm
Volume: 2.25 cc
Area: 420495 pixels^2

Crack 2:
Label: porosity
Length: 1.10 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.07 cc
Area: 17595 pixels^2

Crack 3:
Label: unmelted particle
Length: 0.80 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 11220 pixels^2

Crack 4:
Label: unmelted particle
Length: 0.90 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 14790 pixels^2

Crack 5:
Label: unmelted particle
Length: 1.40 cm
Width: 1.50 cm
Depth: 0.10 cm
Volume: 0.21 cc
Area: 43605 pixels^2

Crack 6:
Label: unmelted particle
Length: 0.70 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 13515 pixels^2
```

```
Crack 7:
Label: unmelted particle
Length: 1.00 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.07 cc
Area: 16575 pixels^2

Crack 8:
Label: unmelted particle
Length: 4.40 cm
Width: 2.40 cm
Depth: 0.10 cm
Volume: 1.06 cc
Area: 170085 pixels^2

Crack 9:
Label: unmelted particle
Length: 0.80 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 15045 pixels^2

Crack 10:
Label: unmelted particle
Length: 3.90 cm
Width: 2.30 cm
Depth: 0.10 cm
Volume: 0.90 cc
Area: 161925 pixels^2

Crack 11:
Label: unmelted particle
Length: 1.20 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.12 cc
Area: 28560 pixels^2

Crack 12:
Label: unmelted particle
Length: 0.80 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 10965 pixels^2

Crack 13:
```

```
Label: unmelted particle
Length: 0.40 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 5355 pixels^2

Crack 14:
Label: unmelted particle
Length: 0.60 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 8670 pixels^2

Crack 15:
Label: porosity
Length: 8.90 cm
Width: 4.10 cm
Depth: 0.10 cm
Volume: 3.65 cc
Area: 447525 pixels^2

Crack 16:
Label: unmelted particle
Length: 0.50 cm
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 4590 pixels^2

Average area of microcracks: 0.00 cm^2
Average area of unmelted particles: 388.38 cm^2
Average area of porosities: 2952.05 cm^2

[06/16 19:11:36 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: porosity
Length: 3.70 cm
Width: 3.00 cm
Depth: 0.10 cm
Volume: 1.11 cc
Area: 215475 pixels^2

Crack 2:
Label: unmelted particle
Length: 2.70 cm
```

```
Width: 2.50 cm
Depth: 0.10 cm
Volume: 0.68 cc
Area: 133110 pixels^2

Crack 3:
Label: porosity
Length: 2.70 cm
Width: 1.70 cm
Depth: 0.10 cm
Volume: 0.46 cc
Area: 82875 pixels^2

Crack 4:
Label: unmelted particle
Length: 2.00 cm
Width: 2.10 cm
Depth: 0.10 cm
Volume: 0.42 cc
Area: 60435 pixels^2

Crack 5:
Label: unmelted particle
Length: 1.10 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.10 cc
Area: 18615 pixels^2

Crack 6:
Label: unmelted particle
Length: 1.20 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.07 cc
Area: 17085 pixels^2

Crack 7:
Label: unmelted particle
Length: 1.50 cm
Width: 1.10 cm
Depth: 0.10 cm
Volume: 0.17 cc
Area: 24480 pixels^2

Crack 8:
Label: unmelted particle
Length: 0.60 cm
Width: 0.50 cm
Depth: 0.10 cm
```

```
Volume: 0.03 cc
Area: 8415 pixels^2

Crack 9:
Label: unmelted particle
Length: 0.90 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.08 cc
Area: 17850 pixels^2

Crack 10:
Label: unmelted particle
Length: 1.60 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.13 cc
Area: 28050 pixels^2

Crack 11:
Label: unmelted particle
Length: 0.80 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 11985 pixels^2

Crack 12:
Label: unmelted particle
Length: 0.60 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 7140 pixels^2

Crack 13:
Label: porosity
Length: 0.40 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 5100 pixels^2

Crack 14:
Label: unmelted particle
Length: 1.20 cm
Width: 1.20 cm
Depth: 0.10 cm
Volume: 0.14 cc
Area: 30855 pixels^2
```

```
Crack 15:
Label: unmelted particle
Length: 0.80 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 15555 pixels^2

Crack 16:
Label: unmelted particle
Length: 0.50 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 7905 pixels^2

Crack 17:
Label: unmelted particle
Length: 0.70 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 9435 pixels^2

Crack 18:
Label: unmelted particle
Length: 0.70 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 9180 pixels^2

Average area of microcracks: 0.00 cm^2
Average area of unmelted particles: 266.73 cm^2
Average area of porosities: 1011.50 cm^2

[06/16 19:11:37 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: unmelted particle
Length: 1.30 cm
Width: 1.20 cm
Depth: 0.10 cm
Volume: 0.16 cc
Area: 38505 pixels^2

Crack 2:
```

```
Label: unmelted particle
Length: 0.60 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 8415 pixels^2

Crack 3:
Label: unmelted particle
Length: 0.70 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 11220 pixels^2

Crack 4:
Label: unmelted particle
Length: 0.80 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 13515 pixels^2

Crack 5:
Label: unmelted particle
Length: 1.80 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.13 cc
Area: 27030 pixels^2

Crack 6:
Label: unmelted particle
Length: 0.80 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 14025 pixels^2

Crack 7:
Label: unmelted particle
Length: 1.90 cm
Width: 1.30 cm
Depth: 0.10 cm
Volume: 0.25 cc
Area: 41055 pixels^2

Crack 8:
Label: unmelted particle
Length: 0.80 cm
```

```
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 8160 pixels^2

Crack 9:
Label: unmelted particle
Length: 1.20 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.07 cc
Area: 15555 pixels^2

Crack 10:
Label: unmelted particle
Length: 0.60 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 7905 pixels^2

Crack 11:
Label: unmelted particle
Length: 0.50 cm
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 4590 pixels^2

Crack 12:
Label: unmelted particle
Length: 0.80 cm
Width: 0.40 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 8670 pixels^2

Crack 13:
Label: unmelted particle
Length: 0.70 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 10455 pixels^2

Crack 14:
Label: unmelted particle
Length: 0.50 cm
Width: 0.40 cm
Depth: 0.10 cm
```

```
Volume: 0.02 cc
Area: 6630 pixels^2

Crack 15:
Label: unmelted particle
Length: 0.30 cm
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.01 cc
Area: 2550 pixels^2

Crack 16:
Label: unmelted particle
Length: 0.50 cm
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 3825 pixels^2

Average area of microcracks: 0.00 cm^2
Average area of unmelted particles: 138.82 cm^2
Average area of porosities: 0.00 cm^2

[06/16 19:11:38 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...
Crack 1:
Label: porosity
Length: 2.80 cm
Width: 2.00 cm
Depth: 0.10 cm
Volume: 0.56 cc
Area: 105570 pixels^2

Crack 2:
Label: unmelted particle
Length: 1.40 cm
Width: 1.30 cm
Depth: 0.10 cm
Volume: 0.18 cc
Area: 37995 pixels^2

Crack 3:
Label: unmelted particle
Length: 1.70 cm
Width: 1.10 cm
Depth: 0.10 cm
Volume: 0.19 cc
Area: 42330 pixels^2
```

```
Crack 4:
Label: unmelted particle
Length: 0.90 cm
Width: 0.80 cm
Depth: 0.10 cm
Volume: 0.07 cc
Area: 16575 pixels^2

Crack 5:
Label: porosity
Length: 0.30 cm
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.01 cc
Area: 3315 pixels^2

Crack 6:
Label: unmelted particle
Length: 0.60 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 9180 pixels^2

Crack 7:
Label: unmelted particle
Length: 0.60 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.04 cc
Area: 10455 pixels^2

Crack 8:
Label: unmelted particle
Length: 0.60 cm
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 5355 pixels^2

Average area of microcracks: 0.00 cm^2
Average area of unmelted particles: 203.15 cm^2
Average area of porosities: 544.43 cm^2


import cv2
import numpy as np
import json
from detectron2.config import get_cfg
```

```
from detectron2.engine import DefaultPredictor, DefaultTrainer
from detectron2.utils.visualizer import Visualizer
from detectron2.data import MetadataCatalog
from google.colab.patches import cv2_imshow
from detectron2 import model_zoo
import os

# Conversion factor: 1 pixel = 0.1 cm (hypothetical value)
conversion_factor = 0.1  # Adjust this value based on your specific
conversion factor

# Load JSON annotations
annotations_path =
'/content/drive/MyDrive/Mahabub/train/rsz_slm_square_finalx15k_0014.js
on'
with open(annotations_path) as f:
    annotations_data = json.load(f)

# Extract annotations
annotations = annotations_data['shapes']

# Load corresponding image
image_path =
'/content/drive/MyDrive/Mahabub/train/rsz_slm_square_finalx15k_0014.jp
g'
image = cv2.imread(image_path)

# Create a black mask image for the background
mask = np.zeros_like(image[:, :, 0], dtype=np.uint8)

# Initialize variables for area calculations
cracks = []
unmelted_particle_area = 0
microcrack_area = 0
porosity_area = 0

# Iterate through annotations and calculate size, shape, volume, and
area for each crack
for annotation in annotations:
    # Extract label and points
    label = annotation['label']
    points = annotation['points']

    # Extract bounding box coordinates
    xmin = int(min(points, key=lambda x: x[0])[0])
    ymin = int(min(points, key=lambda x: x[1])[1])
    xmax = int(max(points, key=lambda x: x[0])[0])
    ymax = int(max(points, key=lambda x: x[1])[1])

    # Extract segmentation mask
```

```
    object_mask = np.zeros_like(image[:, :, 0], dtype=np.uint8)
    cv2.fillPoly(object_mask, np.array([points], dtype=np.int32), 255)

    # Update the main mask based on the label
    if label == 'porosity':
        mask = cv2.bitwise_or(mask, object_mask)
        color = (0, 255, 0)  # Green for porosity
        porosity_area += np.sum(object_mask)
    elif label == 'microcrack':
        mask = cv2.bitwise_or(mask, object_mask)
        color = (0, 0, 255)  # Red for microcrack
        microcrack_area += np.sum(object_mask)
    elif label == 'unmelted particle':
        mask = cv2.bitwise_or(mask, object_mask)
        color = (255, 0, 0)  # Blue for unmelted particle
        unmelted_particle_area += np.sum(object_mask)
    else:
        color = (255, 255, 255)  # White for other objects

    # Draw bounding box and label on the image
    cv2.rectangle(image, (xmin, ymin), (xmax, ymax), color, 2)
    cv2.putText(image, label, (xmin, ymin - 10),
cv2.FONT_HERSHEY_SIMPLEX, 0.9, color, 2)

    # Calculate the size of the crack (length, width, depth) in
centimeters
    length_cm = (xmax - xmin) * conversion_factor
    width_cm = (ymax - ymin) * conversion_factor
    depth_cm = 0.1  # Assuming the depth is 0.1 cm (hypothetical
value)

    # Calculate the volume of the crack in cubic centimeters (cc)
    volume_cc = length_cm * width_cm * depth_cm

    # Create a dictionary to store crack information
    crack = {
        'label': label,
        'length_cm': length_cm,
        'width_cm': width_cm,
        'depth_cm': depth_cm,
        'volume_cc': volume_cc,
        'area': np.sum(object_mask)
    }

    # Add the crack to the list of cracks
    cracks.append(crack)

# Apply the mask to the original image
masked_image = cv2.bitwise_and(image, image, mask=mask)
```

```
# Create a Detectron2 configuration
cfg = get_cfg()
cfg.merge_from_file(model_zoo.get_config_file("COCO-
InstanceSegmentation/mask_rcnn_R_50_FPN_3x.yaml"))
cfg.MODEL.ROI_HEADS.SCORE_THRESH_TEST = 0.5
cfg.MODEL.WEIGHTS = model_zoo.get_checkpoint_url("COCO-
InstanceSegmentation/mask_rcnn_R_50_FPN_3x.yaml")

# Train the model
cfg.DATASETS.TRAIN = ("p_train",)
cfg.DATASETS.TEST = ()
cfg.DATALOADER.NUM_WORKERS = 2
cfg.SOLVER.IMS_PER_BATCH = 2
cfg.SOLVER.BASE_LR = 0.00025
cfg.SOLVER.MAX_ITER = 100
cfg.SOLVER.STEPS = []        # do not decay learning rate
cfg.MODEL.ROI_HEADS.NUM_CLASSES = 3

os.makedirs(cfg.OUTPUT_DIR, exist_ok=True)
trainer = DefaultTrainer(cfg)
trainer.resume_or_load(resume=False)
trainer.train()

# Continue with the rest of the code...

# Run the Mask R-CNN model on the image
predictor = DefaultPredictor(cfg)
outputs = predictor(image)

# Visualize the predictions
v = Visualizer(image[:, :, ::-1],
MetadataCatalog.get(cfg.DATASETS.TRAIN[0]), scale=1.2)
out = v.draw_instance_predictions(outputs["instances"].to("cpu"))

# Get the annotated image
annotated_image = out.get_image()[:, :, ::-1]

# Calculate average areas
num_unmelted_particles = sum(1 for annotation in annotations if
annotation['label'] == 'unmelted particle')
num_microcracks = sum(1 for annotation in annotations if
annotation['label'] == 'microcrack')
num_porosities = sum(1 for annotation in annotations if
annotation['label'] == 'porosity')

average_unmelted_particle_area = (unmelted_particle_area /
num_unmelted_particles) * (conversion_factor ** 2) if
num_unmelted_particles > 0 else 0
average_microcrack_area = (microcrack_area / num_microcracks) *
(conversion_factor ** 2) if num_microcracks > 0 else 0
```

```
average_porosity_area = (porosity_area / num_porosities) *
(conversion_factor ** 2) if num_porosities > 0 else 0

# Print crack information
for i, crack in enumerate(cracks):
    print(f"Crack {i+1}:")
    print(f"Label: {crack['label']}")
    print(f"Length: {crack['length_cm']:.2f} cm")
    print(f"Width: {crack['width_cm']:.2f} cm")
    print(f"Depth: {crack['depth_cm']:.2f} cm")
    print(f"Volume: {crack['volume_cc']:.2f} cc")
    print(f"Area: {crack['area']} pixels^2\n")

# Print average area calculations
print(f"Average area of microcracks: {average_microcrack_area:.2f}
cm^2")
print(f"Average area of porosity: {average_porosity_area:.2f} cm^2")
print(f"Average area of unmelted particles:
{average_unmelted_particle_area:.2f} cm^2")
```

```
[06/16 19:51:03 d2.engine.defaults]: Model:
GeneralizedRCNN(
  (backbone): FPN(
    (fpn_lateral2): Conv2d(256, 256, kernel_size=(1, 1), stride=(1,
1))
    (fpn_output2): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1))
    (fpn_lateral3): Conv2d(512, 256, kernel_size=(1, 1), stride=(1,
1))
    (fpn_output3): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1))
    (fpn_lateral4): Conv2d(1024, 256, kernel_size=(1, 1), stride=(1,
1))
    (fpn_output4): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1))
    (fpn_lateral5): Conv2d(2048, 256, kernel_size=(1, 1), stride=(1,
1))
    (fpn_output5): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1))
    (top_block): LastLevelMaxPool()
    (bottom_up): ResNet(
      (stem): BasicStem(
        (conv1): Conv2d(
          3, 64, kernel_size=(7, 7), stride=(2, 2), padding=(3, 3),
bias=False
          (norm): FrozenBatchNorm2d(num_features=64, eps=1e-05)
        )
      )
      (res2): Sequential(
        (0): BottleneckBlock(
```

```
          (shortcut): Conv2d(
            64, 256, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
          (conv1): Conv2d(
            64, 64, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=64, eps=1e-05)
          )
          (conv2): Conv2d(
            64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1),
bias=False
            (norm): FrozenBatchNorm2d(num_features=64, eps=1e-05)
          )
          (conv3): Conv2d(
            64, 256, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
        )
        (1): BottleneckBlock(
          (conv1): Conv2d(
            256, 64, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=64, eps=1e-05)
          )
          (conv2): Conv2d(
            64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1),
bias=False
            (norm): FrozenBatchNorm2d(num_features=64, eps=1e-05)
          )
          (conv3): Conv2d(
            64, 256, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
        )
        (2): BottleneckBlock(
          (conv1): Conv2d(
            256, 64, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=64, eps=1e-05)
          )
          (conv2): Conv2d(
            64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1),
bias=False
            (norm): FrozenBatchNorm2d(num_features=64, eps=1e-05)
          )
          (conv3): Conv2d(
            64, 256, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
        )
      )
```

```
      (res3): Sequential(
        (0): BottleneckBlock(
          (shortcut): Conv2d(
            256, 512, kernel_size=(1, 1), stride=(2, 2), bias=False
            (norm): FrozenBatchNorm2d(num_features=512, eps=1e-05)
          )
          (conv1): Conv2d(
            256, 128, kernel_size=(1, 1), stride=(2, 2), bias=False
            (norm): FrozenBatchNorm2d(num_features=128, eps=1e-05)
          )
          (conv2): Conv2d(
            128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), bias=False
            (norm): FrozenBatchNorm2d(num_features=128, eps=1e-05)
          )
          (conv3): Conv2d(
            128, 512, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=512, eps=1e-05)
          )
        )
        (1): BottleneckBlock(
          (conv1): Conv2d(
            512, 128, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=128, eps=1e-05)
          )
          (conv2): Conv2d(
            128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), bias=False
            (norm): FrozenBatchNorm2d(num_features=128, eps=1e-05)
          )
          (conv3): Conv2d(
            128, 512, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=512, eps=1e-05)
          )
        )
        (2): BottleneckBlock(
          (conv1): Conv2d(
            512, 128, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=128, eps=1e-05)
          )
          (conv2): Conv2d(
            128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), bias=False
            (norm): FrozenBatchNorm2d(num_features=128, eps=1e-05)
          )
          (conv3): Conv2d(
            128, 512, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=512, eps=1e-05)
          )
```

```
        )
        (3): BottleneckBlock(
          (conv1): Conv2d(
            512, 128, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=128, eps=1e-05)
          )
          (conv2): Conv2d(
            128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), bias=False
            (norm): FrozenBatchNorm2d(num_features=128, eps=1e-05)
          )
          (conv3): Conv2d(
            128, 512, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=512, eps=1e-05)
          )
        )
      )
      (res4): Sequential(
        (0): BottleneckBlock(
          (shortcut): Conv2d(
            512, 1024, kernel_size=(1, 1), stride=(2, 2), bias=False
            (norm): FrozenBatchNorm2d(num_features=1024, eps=1e-05)
          )
          (conv1): Conv2d(
            512, 256, kernel_size=(1, 1), stride=(2, 2), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
          (conv2): Conv2d(
            256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
          (conv3): Conv2d(
            256, 1024, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=1024, eps=1e-05)
          )
        )
        (1): BottleneckBlock(
          (conv1): Conv2d(
            1024, 256, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
          (conv2): Conv2d(
            256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
          (conv3): Conv2d(
            256, 1024, kernel_size=(1, 1), stride=(1, 1), bias=False
```

```
            (norm): FrozenBatchNorm2d(num_features=1024, eps=1e-05)
          )
        )
        (2): BottleneckBlock(
          (conv1): Conv2d(
            1024, 256, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
          (conv2): Conv2d(
            256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
          (conv3): Conv2d(
            256, 1024, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=1024, eps=1e-05)
          )
        )
        (3): BottleneckBlock(
          (conv1): Conv2d(
            1024, 256, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
          (conv2): Conv2d(
            256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
          (conv3): Conv2d(
            256, 1024, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=1024, eps=1e-05)
          )
        )
        (4): BottleneckBlock(
          (conv1): Conv2d(
            1024, 256, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
          (conv2): Conv2d(
            256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
          (conv3): Conv2d(
            256, 1024, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=1024, eps=1e-05)
          )
        )
        (5): BottleneckBlock(
```

```
          (conv1): Conv2d(
            1024, 256, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
          (conv2): Conv2d(
            256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
          (conv3): Conv2d(
            256, 1024, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=1024, eps=1e-05)
          )
        )
      )
      (res5): Sequential(
        (0): BottleneckBlock(
          (shortcut): Conv2d(
            1024, 2048, kernel_size=(1, 1), stride=(2, 2), bias=False
            (norm): FrozenBatchNorm2d(num_features=2048, eps=1e-05)
          )
          (conv1): Conv2d(
            1024, 512, kernel_size=(1, 1), stride=(2, 2), bias=False
            (norm): FrozenBatchNorm2d(num_features=512, eps=1e-05)
          )
          (conv2): Conv2d(
            512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), bias=False
            (norm): FrozenBatchNorm2d(num_features=512, eps=1e-05)
          )
          (conv3): Conv2d(
            512, 2048, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=2048, eps=1e-05)
          )
        )
        (1): BottleneckBlock(
          (conv1): Conv2d(
            2048, 512, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=512, eps=1e-05)
          )
          (conv2): Conv2d(
            512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), bias=False
            (norm): FrozenBatchNorm2d(num_features=512, eps=1e-05)
          )
          (conv3): Conv2d(
            512, 2048, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=2048, eps=1e-05)
          )
```

```
        )
        (2): BottleneckBlock(
          (conv1): Conv2d(
            2048, 512, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=512, eps=1e-05)
          )
          (conv2): Conv2d(
            512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), bias=False
            (norm): FrozenBatchNorm2d(num_features=512, eps=1e-05)
          )
          (conv3): Conv2d(
            512, 2048, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=2048, eps=1e-05)
          )
        )
      )
    )
  )
  (proposal_generator): RPN(
    (rpn_head): StandardRPNHead(
      (conv): Conv2d(
        256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1)
        (activation): ReLU()
      )
      (objectness_logits): Conv2d(256, 3, kernel_size=(1, 1),
stride=(1, 1))
      (anchor_deltas): Conv2d(256, 12, kernel_size=(1, 1), stride=(1,
1))
    )
    (anchor_generator): DefaultAnchorGenerator(
      (cell_anchors): BufferList()
    )
  )
  (roi_heads): StandardROIHeads(
    (box_pooler): ROIPooler(
      (level_poolers): ModuleList(
        (0): ROIAlign(output_size=(7, 7), spatial_scale=0.25,
sampling_ratio=0, aligned=True)
        (1): ROIAlign(output_size=(7, 7), spatial_scale=0.125,
sampling_ratio=0, aligned=True)
        (2): ROIAlign(output_size=(7, 7), spatial_scale=0.0625,
sampling_ratio=0, aligned=True)
        (3): ROIAlign(output_size=(7, 7), spatial_scale=0.03125,
sampling_ratio=0, aligned=True)
      )
    )
    (box_head): FastRCNNConvFCHead(
      (flatten): Flatten(start_dim=1, end_dim=-1)
```

```
      (fc1): Linear(in_features=12544, out_features=1024, bias=True)
      (fc_relu1): ReLU()
      (fc2): Linear(in_features=1024, out_features=1024, bias=True)
      (fc_relu2): ReLU()
    )
    (box_predictor): FastRCNNOutputLayers(
      (cls_score): Linear(in_features=1024, out_features=4, bias=True)
      (bbox_pred): Linear(in_features=1024, out_features=12,
bias=True)
    )
    (mask_pooler): ROIPooler(
      (level_poolers): ModuleList(
        (0): ROIAlign(output_size=(14, 14), spatial_scale=0.25,
sampling_ratio=0, aligned=True)
        (1): ROIAlign(output_size=(14, 14), spatial_scale=0.125,
sampling_ratio=0, aligned=True)
        (2): ROIAlign(output_size=(14, 14), spatial_scale=0.0625,
sampling_ratio=0, aligned=True)
        (3): ROIAlign(output_size=(14, 14), spatial_scale=0.03125,
sampling_ratio=0, aligned=True)
      )
    )
    (mask_head): MaskRCNNConvUpsampleHead(
      (mask_fcn1): Conv2d(
        256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1)
        (activation): ReLU()
      )
      (mask_fcn2): Conv2d(
        256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1)
        (activation): ReLU()
      )
      (mask_fcn3): Conv2d(
        256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1)
        (activation): ReLU()
      )
      (mask_fcn4): Conv2d(
        256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1)
        (activation): ReLU()
      )
      (deconv): ConvTranspose2d(256, 256, kernel_size=(2, 2),
stride=(2, 2))
      (deconv_relu): ReLU()
      (predictor): Conv2d(256, 3, kernel_size=(1, 1), stride=(1, 1))
    )
  )
)
[06/16 19:51:03 d2.data.build]: Removed 0 images with no usable
annotations. 42 images left.
[06/16 19:51:03 d2.data.dataset_mapper]: [DatasetMapper] Augmentations
```

```
used in training: [ResizeShortestEdge(short_edge_length=(640, 672,
704, 736, 768, 800), max_size=1333, sample_style='choice'),
RandomFlip()]
[06/16 19:51:03 d2.data.build]: Using training sampler TrainingSampler
[06/16 19:51:03 d2.data.common]: Serializing the dataset using: <class
'detectron2.data.common._TorchSerializedList'>
[06/16 19:51:03 d2.data.common]: Serializing 42 elements to byte
tensors and concatenating them all ...
[06/16 19:51:03 d2.data.common]: Serialized dataset takes 0.16 MiB
[06/16 19:51:03 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...

WARNING:fvcore.common.checkpoint:Skip loading parameter
'roi_heads.box_predictor.cls_score.weight' to the model due to
incompatible shapes: (81, 1024) in the checkpoint but (4, 1024) in the
model! You might want to double check if this is expected.
WARNING:fvcore.common.checkpoint:Skip loading parameter
'roi_heads.box_predictor.cls_score.bias' to the model due to
incompatible shapes: (81,) in the checkpoint but (4,) in the model!
You might want to double check if this is expected.
WARNING:fvcore.common.checkpoint:Skip loading parameter
'roi_heads.box_predictor.bbox_pred.weight' to the model due to
incompatible shapes: (320, 1024) in the checkpoint but (12, 1024) in
the model! You might want to double check if this is expected.
WARNING:fvcore.common.checkpoint:Skip loading parameter
'roi_heads.box_predictor.bbox_pred.bias' to the model due to
incompatible shapes: (320,) in the checkpoint but (12,) in the model!
You might want to double check if this is expected.
WARNING:fvcore.common.checkpoint:Skip loading parameter
'roi_heads.mask_head.predictor.weight' to the model due to
incompatible shapes: (80, 256, 1, 1) in the checkpoint but (3, 256, 1,
1) in the model! You might want to double check if this is expected.
WARNING:fvcore.common.checkpoint:Skip loading parameter
'roi_heads.mask_head.predictor.bias' to the model due to incompatible
shapes: (80,) in the checkpoint but (3,) in the model! You might want
to double check if this is expected.
WARNING:fvcore.common.checkpoint:Some model parameters or buffers are
not found in the checkpoint:
roi_heads.box_predictor.bbox_pred.{bias, weight}
roi_heads.box_predictor.cls_score.{bias, weight}
roi_heads.mask_head.predictor.{bias, weight}

[06/16 19:51:03 d2.engine.train_loop]: Starting training from
iteration 0
[06/16 19:51:06 d2.utils.events]:  eta: 0:00:10  iter: 19  total_loss:
3.415  loss_cls: 1.495  loss_box_reg: 0.6997  loss_mask: 0.6921
loss_rpn_cls: 0.4272  loss_rpn_loc: 0.2339    time: 0.1302  last_time:
0.1295  data_time: 0.0124  last_data_time: 0.0052   lr: 4.7703e-05
```

```
max_mem: 3911M
[06/16 19:51:08 d2.utils.events]:  eta: 0:00:07  iter: 39  total_loss:
2.186  loss_cls: 0.7188  loss_box_reg: 0.5785  loss_mask: 0.652
loss_rpn_cls: 0.05312  loss_rpn_loc: 0.2155    time: 0.1289
last_time: 0.1309  data_time: 0.0047  last_data_time: 0.0044   lr:
9.7653e-05  max_mem: 3911M
[06/16 19:51:11 d2.utils.events]:  eta: 0:00:05  iter: 59  total_loss:
1.779  loss_cls: 0.419  loss_box_reg: 0.5263  loss_mask: 0.5814
loss_rpn_cls: 0.03642  loss_rpn_loc: 0.2014    time: 0.1282
last_time: 0.1334  data_time: 0.0047  last_data_time: 0.0052   lr:
0.0001476  max_mem: 3911M
[06/16 19:51:13 d2.utils.events]:  eta: 0:00:02  iter: 79  total_loss:
1.613  loss_cls: 0.3167  loss_box_reg: 0.5645  loss_mask: 0.493
loss_rpn_cls: 0.03272  loss_rpn_loc: 0.2083    time: 0.1284
last_time: 0.1304  data_time: 0.0047  last_data_time: 0.0047   lr:
0.00019755  max_mem: 3911M
[06/16 19:51:17 d2.utils.events]:  eta: 0:00:00  iter: 99  total_loss:
1.495  loss_cls: 0.2427  loss_box_reg: 0.5749  loss_mask: 0.4522
loss_rpn_cls: 0.03153  loss_rpn_loc: 0.2049    time: 0.1322
last_time: 0.1183  data_time: 0.0047  last_data_time: 0.0046   lr:
0.0002475  max_mem: 3911M
[06/16 19:51:18 d2.engine.hooks]: Overall training speed: 98
iterations in 0:00:12 (0.1322 s / it)
[06/16 19:51:18 d2.engine.hooks]: Total training time: 0:00:14
(0:00:02 on hooks)
[06/16 19:51:19 d2.checkpoint.detection_checkpoint]:
[DetectionCheckpointer] Loading from
https://dl.fbaipublicfiles.com/detectron2/COCO-InstanceSegmentation/
mask_rcnn_R_50_FPN_3x/137849600/model_final_f10217.pkl ...

WARNING:fvcore.common.checkpoint:Skip loading parameter
'roi_heads.box_predictor.cls_score.weight' to the model due to
incompatible shapes: (81, 1024) in the checkpoint but (4, 1024) in the
model! You might want to double check if this is expected.
WARNING:fvcore.common.checkpoint:Skip loading parameter
'roi_heads.box_predictor.cls_score.bias' to the model due to
incompatible shapes: (81,) in the checkpoint but (4,) in the model!
You might want to double check if this is expected.
WARNING:fvcore.common.checkpoint:Skip loading parameter
'roi_heads.box_predictor.bbox_pred.weight' to the model due to
incompatible shapes: (320, 1024) in the checkpoint but (12, 1024) in
the model! You might want to double check if this is expected.
WARNING:fvcore.common.checkpoint:Skip loading parameter
'roi_heads.box_predictor.bbox_pred.bias' to the model due to
incompatible shapes: (320,) in the checkpoint but (12,) in the model!
You might want to double check if this is expected.
WARNING:fvcore.common.checkpoint:Skip loading parameter
'roi_heads.mask_head.predictor.weight' to the model due to
incompatible shapes: (80, 256, 1, 1) in the checkpoint but (3, 256, 1,
1) in the model! You might want to double check if this is expected.
```

```
WARNING:fvcore.common.checkpoint:Skip loading parameter
'roi_heads.mask_head.predictor.bias' to the model due to incompatible
shapes: (80,) in the checkpoint but (3,) in the model! You might want
to double check if this is expected.
WARNING:fvcore.common.checkpoint:Some model parameters or buffers are
not found in the checkpoint:
roi_heads.box_predictor.bbox_pred.{bias, weight}
roi_heads.box_predictor.cls_score.{bias, weight}
roi_heads.mask_head.predictor.{bias, weight}

Crack 1:
Label: microcrack
Length: 8.10 cm
Width: 12.00 cm
Depth: 0.10 cm
Volume: 9.72 cc
Area: 514845 pixels^2

Crack 2:
Label: unmelted particle
Length: 1.60 cm
Width: 1.00 cm
Depth: 0.10 cm
Volume: 0.16 cc
Area: 33660 pixels^2

Crack 3:
Label: unmelted particle
Length: 3.00 cm
Width: 2.10 cm
Depth: 0.10 cm
Volume: 0.63 cc
Area: 118065 pixels^2

Crack 4:
Label: unmelted particle
Length: 0.60 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.03 cc
Area: 9180 pixels^2

Crack 5:
Label: unmelted particle
Length: 2.20 cm
Width: 1.70 cm
Depth: 0.10 cm
Volume: 0.37 cc
Area: 61455 pixels^2
```

```
Crack 6:
Label: unmelted particle
Length: 0.90 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.08 cc
Area: 16575 pixels^2

Crack 7:
Label: unmelted particle
Length: 2.50 cm
Width: 2.50 cm
Depth: 0.10 cm
Volume: 0.62 cc
Area: 99195 pixels^2

Crack 8:
Label: porosity
Length: 1.20 cm
Width: 0.90 cm
Depth: 0.10 cm
Volume: 0.11 cc
Area: 25755 pixels^2

Crack 9:
Label: porosity
Length: 0.70 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 11985 pixels^2

Crack 10:
Label: unmelted particle
Length: 0.80 cm
Width: 0.70 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 14280 pixels^2

Crack 11:
Label: unmelted particle
Length: 0.90 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 10710 pixels^2

Crack 12:
Label: unmelted particle
```

```
Length: 0.40 cm
Width: 0.50 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 6630 pixels^2

Crack 13:
Label: porosity
Length: 0.80 cm
Width: 0.60 cm
Depth: 0.10 cm
Volume: 0.05 cc
Area: 11985 pixels^2

Crack 14:
Label: microcrack
Length: 0.50 cm
Width: 1.10 cm
Depth: 0.10 cm
Volume: 0.06 cc
Area: 14535 pixels^2

Crack 15:
Label: unmelted particle
Length: 0.70 cm
Width: 0.30 cm
Depth: 0.10 cm
Volume: 0.02 cc
Area: 5100 pixels^2

Average area of microcracks: 2646.90 cm^2
Average area of porosity: 165.75 cm^2
Average area of unmelted particles: 374.85 cm^2
```