Guide

1.About the program

xdatabase.m

This file is a database of baseline samples and test samples. Database contains the information of the samples, such as filename, radius of mirror, thickness and so on. Follow the instructions to add or delete the information of the samples if you want. The information will be used later.

baseprocess.m

This program is used for processing the images of the baseline samples in the database. It can flip the image to the right position, detect the free surface edge to make it horizontal, extract the ROI(region of interest) of the image manually through GUI and transform it to binary image.

testprocess.m

This function is used for processing the images of the test samples in the database. Input the number of test sample in database and this function will flip the image to the right position, detect the free surface edge to make it horizontal, extract the ROI(region of interest) of the image manually through GUI and transform it to binary image.

CValgorithm.m

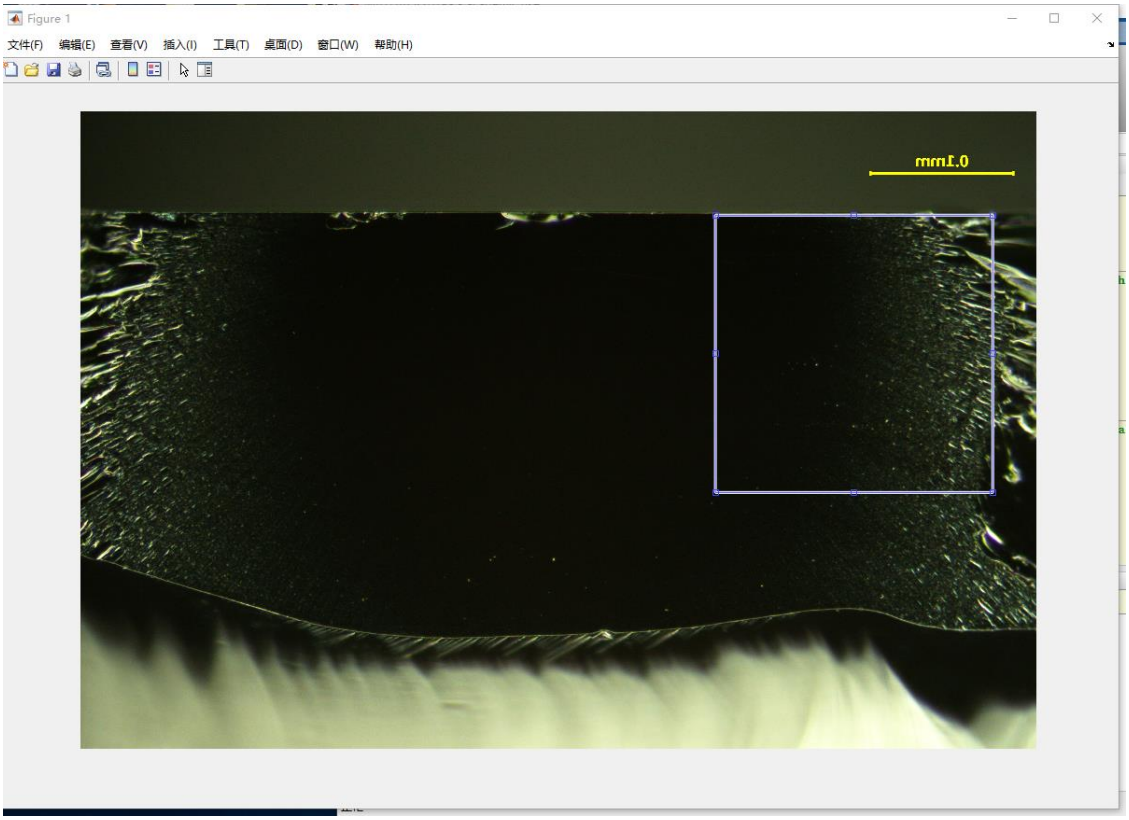
This program is used for calculating the value of R/H and strength. It will output the scatter plot, fit curve, estimated R/H value and estimated strength.

2.How to take images

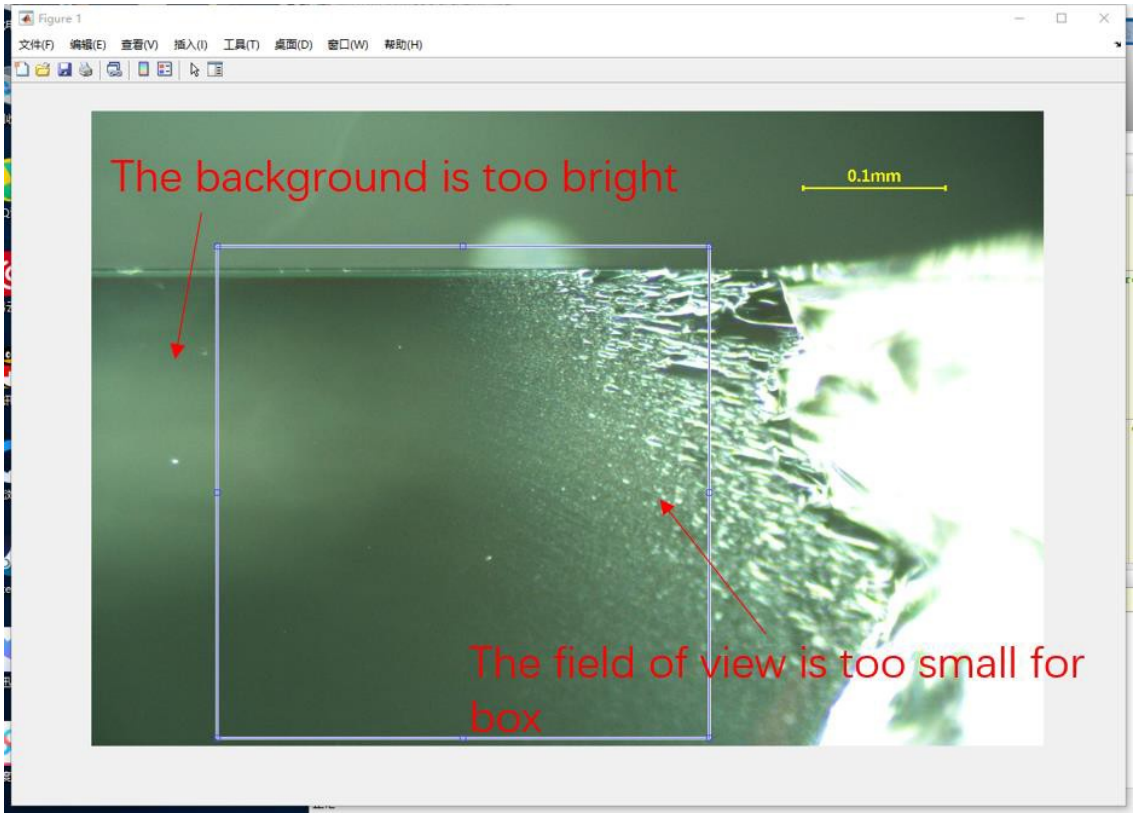
The images which can be used by the program should satisfy the following standards.

1. Use dark field mode to take. The background of the images should be dark enough, which means the mirror would better be black, mist would better be white and the distinction is clear. To achieve this, when you take images, you should keep out the ambient light and adjust the light intensity of microscope to proper level.
2. The field of view of the images should be big enough to extract the ROI. The size of ROI is determined by the radius of mirror and thickness of the sample. Your images should be able to contain the ROI. You can change the magnification times of the microscope to get proper images. Small magnification times will have a big field of view. 10 times magnification is suitable for most samples in general. However, it doesn't mean small magnification times is always good. The mist region of some samples is not obvious under small magnification times.
3. Make the free surface edge as horizontal as possible when you take the images. Although the program can detect the edge and make it horizontal, the angle between the free surface edge and horizontal should not bigger than 15 degrees. And the edge detection is not effective for all images. Some samples don't have obvious straight-line free surface edge, which may be caused by damages. In this case, edge detection is not accurate. The rotation of the image will cause distortion which may affect the result. To put it in a nut shell, try to make the edge horizontal.
4. Make the fracture surface as clean as possible. The fracture surface should be clean enough because dirty things will cause bright points or regions on the images, and when they convert to binary images, these points or regions look just like the mist region. It's very harmful for the estimated results.

Here are some examples you can refer to.
Good example:



Bad example:



3.How to use the program

1.Add/Delete samples in database

If you don't want to add or delete samples in database, you can jump to step 2. If you want, you should know how to add/delete samples in database.

For adding samples, first, you should move the images' files to the corresponding file folders in the file folder named CV method. Images of baseline should be moved to file folder named base. Images of test samples should be moved to file folder named test. Then you should add their information in the database.

For baseline samples, you should add their information as follows.

```
DB(1,:) = {'\base processed\2.tif'    0.094358974   184     2000  2 '\base\2 20x.tif'    2};
```

DB represents the cell matrix to store the information of baseline samples. 1 represents the sample is the first baseline sample in database. The elements of this row, in turn, represent the file folder which saves the image processed and name of image processed, R/H value of the sample, radius of mirror(unit: micron) of the sample, thickness of the sample, magnification factor of the sample, the file folder which save the primitive image and the name of primitive image and the position factor which is determined by the location of the origin point on the image.

For magnification factor, 1, 2 and 3 represent 10 times magnification, 20 times magnification, 50 times magnification respectively.

For position factor, you can check the chart below to determine which numbers to type in.

Origin location	Position factor
Upper-left	0
Lower-left	1
Upper-right	2
Lower-right	3

For test samples, you should add their information as the followings.

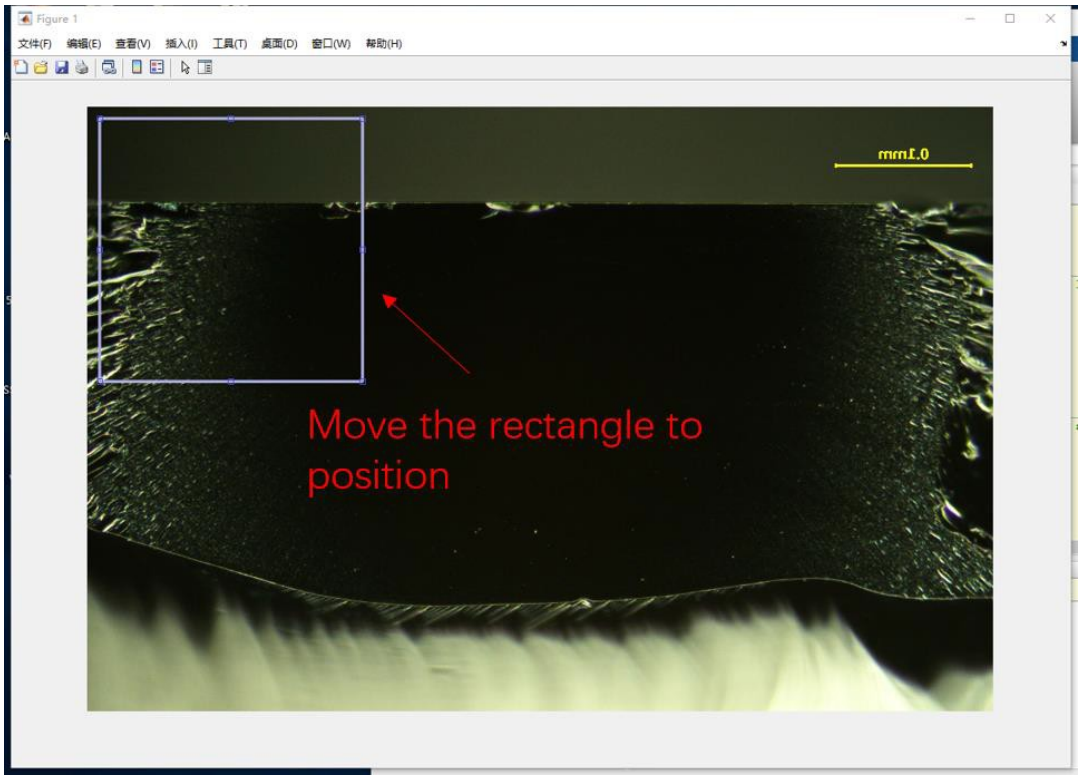
```
for i=1:11
   name1='\test processed\slg 2mm\14t NUM.tif';
   name=strrep(name1,'NUM',num2str(i));
   TB{1,i}=name;
end
TB{1,12}=328;TB{1,13}=2000;TB{1,14}=2;TB{1,15}='\test\14 20x.tif';TB{1,16}=0;
```

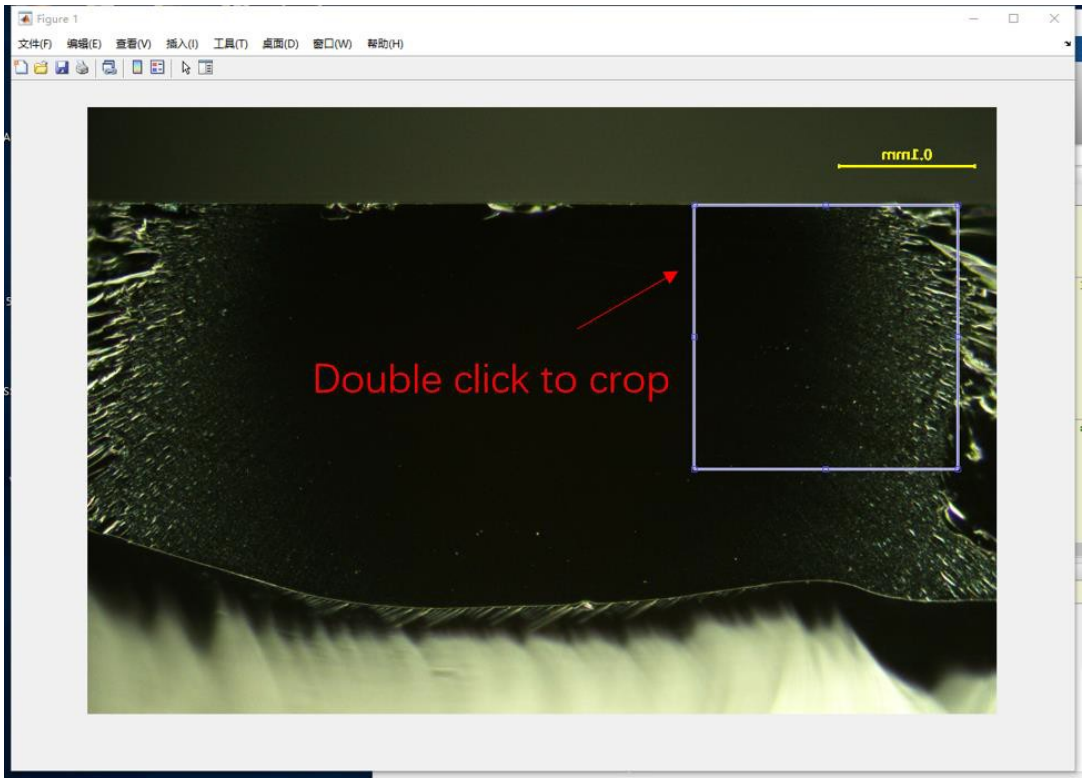
TB represents the cell matrix to store the information of test samples. 1 represents the sample is the first test sample in database. The first 11 elements represent the file folder which saves the image processed and name of image processed. 11 different ROI images will be extracted from test samples given the serial number. The latter elements, in turn, represent radius of mirror(unit: micron) of the sample, thickness of the sample, magnification factor of the sample, the file folder which save the primitive image and the name of primitive image and the position factor which is determined by the same way as baseline samples.

For deleting samples, you should delete the corresponding rows of the cell matrix. For baseline samples, you should also make the order number of the rows in turn.

2.Run baseprocess.m if you add/delete baseline samples

If you don't add or delete baseline samples in the database, you can jump to step 3. If you add or delete the baseline samples in the database. You should run the program named baseprocess.m to get the baseline image processed. The process consists of the rotation of the image, ROI extraction and transformation of the ROI images to binary ROI images. The process is automatic except the ROI extraction. You should select the ROI through the GUI. The program will pop up a figure showing the image which is flipped to the right position. There will be a rectangle on the image, whose size is determined by the radius of mirror and thickness of each sample. So do not change the size of the rectangle. The part of the image which is inside the rectangle will be extracted as ROI. You should move the rectangle to the position you want then double click to extract. The ROI selection rule is the free surface edge should be overlapped with the top side of the rectangle. And the ratio between the length of the mirror part and the length of the mist/hackle part should be approximately 1:2.





3.Run CValgorithm.m

If you don’t add or delete any samples, you can skip to this step. If you don’t add or delete any baseline samples, after you have done the step 1, you can skip to this step. Run the program named CValgorithm.m to get started. Then the program will ask you to input the number of the test sample you want to analyze. The number should be valid, if not , the program will warn you the invalidity of the number inputted. After that, the program will pop up a figure letting you to select ROI of the test sample. There will be a rectangle on the image, whose size is determined by the radius of mirror and thickness of each sample. So do not change the size of the rectangle. The part of the image which is inside the rectangle will be extracted as ROI. You should move the rectangle to the position you want then double click to extract. The ROI selection rule is the free surface edge should be overlapped with the top side of the rectangle. And the ratio between the length of the mirror part and the length of the mist/hackle part should be approximately 1:2. If the ROI selected is invalid, which means some parts of the rectangle is beyond the boundary of the image, it will warn you no effective test images. Finally, the program will pop up a figure showing the scatter plot and fit curve of the result. The estimated R/H value and strength will be shown in the command line window.