In [1]:
```
import pandas as pd
import numpy as np
import matplotlib as mpl
import matplotlib.pyplot as plt
```

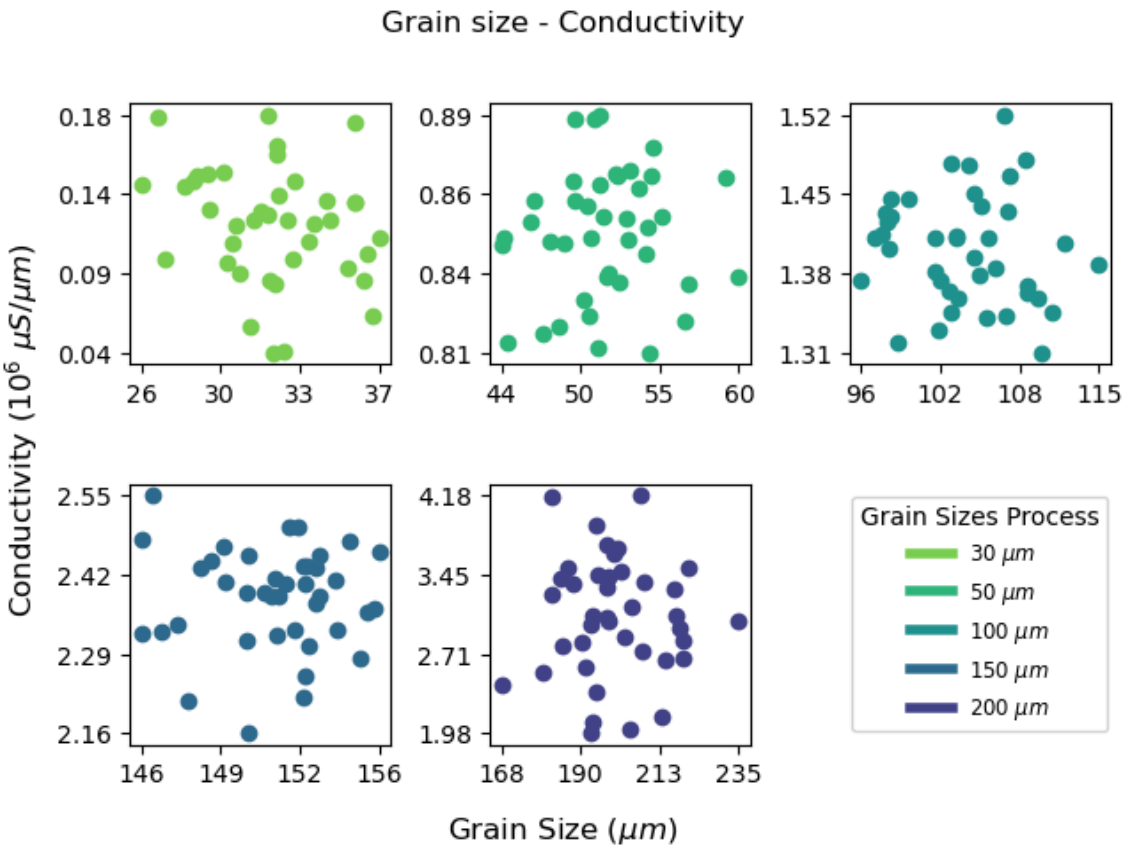
In [2]:
```
df = pd.read_csv("conductivity.csv")

def rename_cols(name):
    if "um Measured Grain Size" in name:
        return name.split()[0] + " size"
    elif "um Measured Conductivity" in name:
        return name.split()[0] + " cond"
    return name
df.rename(columns=rename_cols, inplace=True)

SIZES = list(map(lambda x: int(x.split()[0]), df.columns[::2]))
COLORS = mpl.colormaps["viridis"](np.linspace(0.8,0.2,len(SIZES)))

print(f"Grain sizes: {SIZES}")
df.head()
```

```
Grain sizes: [30, 50, 100, 150, 200]
```

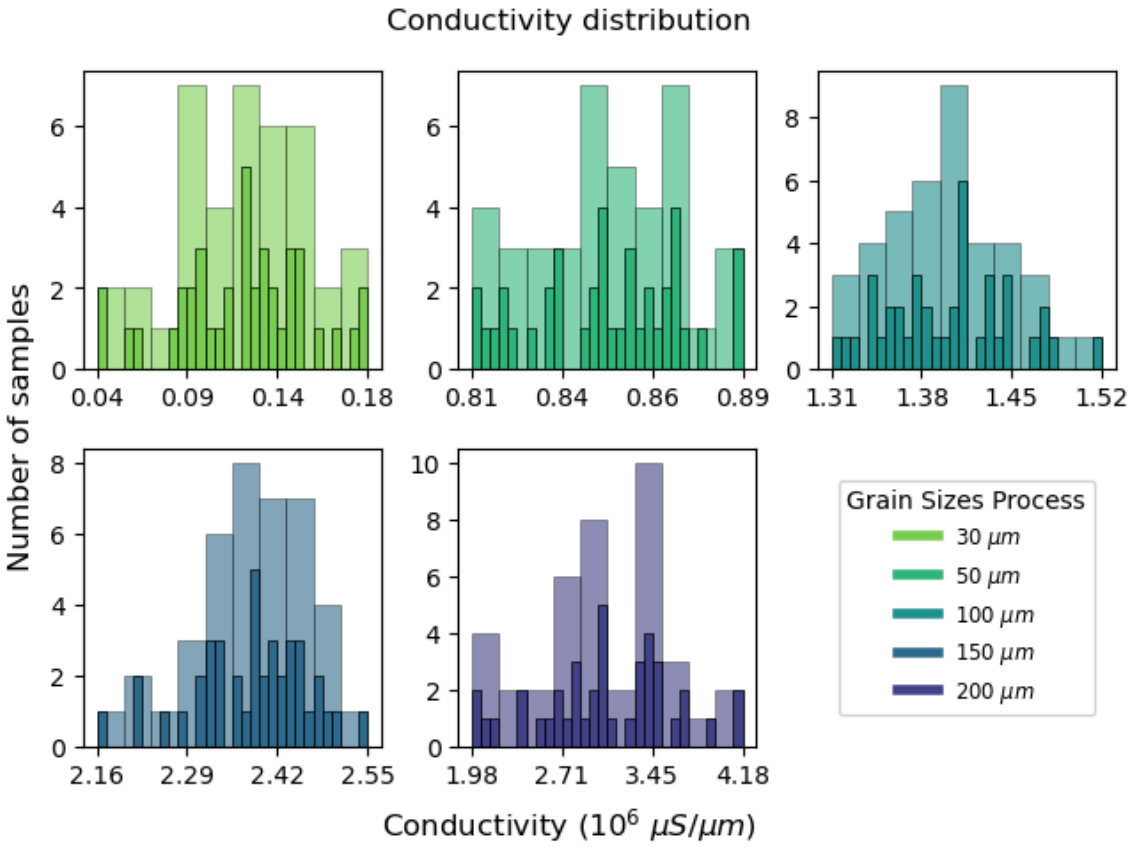
Out[2]:

	30 size	30 cond	50 size	50 cond	100 size	100 cond	150 size	1
0	26.385649	141705.1825	49.769497	825209.8877	105.342663	1440434.048	153.800434	241
1	29.228651	148833.0212	52.697096	847810.3431	104.830058	1450762.442	153.095156	245
2	30.453191	118277.3573	47.129357	812651.5561	112.139189	1406715.305	150.053214	231
3	32.192275	164828.1108	46.260877	854437.4576	101.684618	1410339.581	146.349020	233
4	34.530680	121587.3704	56.383056	817096.2876	101.932903	1325916.462	152.059725	233

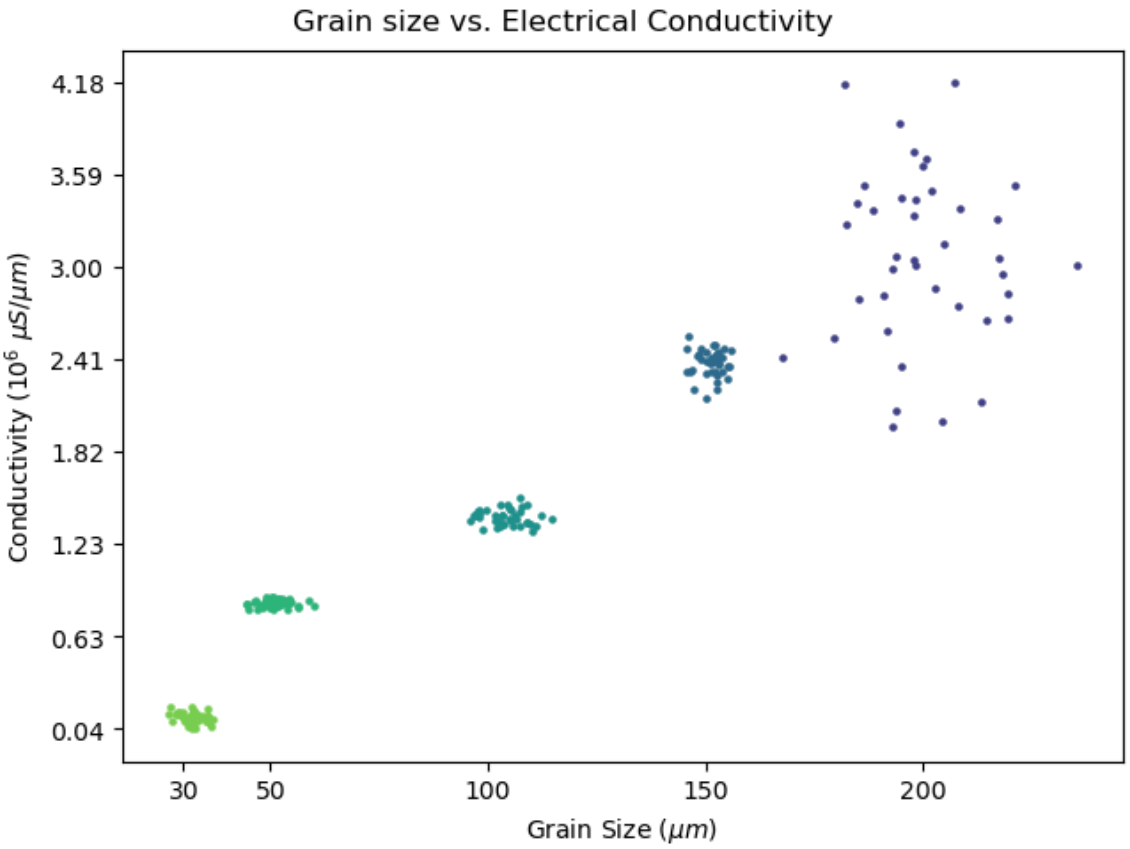
In [3]:
```
fig, axs = plt.subplots(2, 3, layout="constrained")

for i, size in enumerate(SIZES):
    ax = axs[i // 3, i % 3]
    ax.set_yticks(np.linspace(min(df[f"{size} cond"]), max(df[f"{size} con
d"]), 4))
    ax.set_xticks(np.linspace(min(df[f"{size} size"]), max(df[f"{size} siz
e"]), 4))
    ax.yaxis.set_major_formatter(mpl.ticker.FuncFormatter(lambda x, pos: f"
{x*1e-6:.2f}"))
    ax.xaxis.set_major_formatter(mpl.ticker.FuncFormatter(lambda x, pos: f"
{x:.0f}"))
    ax.scatter(df[f"{size} size"], df[f"{size} cond"], color=COLORS[i])
    ax.set_aspect(1.0/ax.get_data_ratio(), adjustable="box")

axs[-1,-1].legend(handles=[mpl.lines.Line2D([0], [0], color=COLORS[i], lw=
4) for i in range(len(SIZES))],
                  labels=[f"{size} " + r"$\mu m$" for size in SIZES],
                  title="Grain Sizes Process", loc='center', fontsize='smal
l')
axs[-1,-1].axis('off')

fig.supxlabel(r"Grain Size ($\mu m $)")
fig.supylabel(r"Conductivity ($10^6\ \mu S/\mu m$)")
plt.suptitle("Grain size - Conductivity")
plt.show()
```



In [4]:
```
fig, axs = plt.subplots(2, 3, layout="constrained")

for i, size in enumerate(SIZES):
    ax = axs[i // 3, i % 3]
    ax.hist(df[f"{size} cond"], color=COLORS[i], bins=10, edgecolor="blac
k", alpha=0.6, linewidth=0.4)
    ax.hist(df[f"{size} cond"], color=COLORS[i], bins=30, edgecolor="blac
k", linewidth=0.5)
    ax.set_xticks(np.linspace(min(df[f"{size} cond"]), max(df[f"{size} con
d"]), 4))
    ax.yaxis.set_major_formatter(mpl.ticker.FuncFormatter(lambda x, pos: f"
{x:.0f}"))
    ax.xaxis.set_major_formatter(mpl.ticker.FuncFormatter(lambda x, pos: f"
{x*1e-6:.2f}"))
    ax.set_aspect(1.0/ax.get_data_ratio(), adjustable="box")

axs[-1,-1].legend(handles=[mpl.lines.Line2D([0], [0], color=COLORS[i], lw=
4) for i in range(len(SIZES))],
                  labels=[f"{size} " + r"$\mu m$" for size in SIZES],
                  title="Grain Sizes Process", loc='center', fontsize='smal
l')
axs[-1,-1].axis('off')


fig.supylabel(r"Number of samples")
fig.supxlabel(r"Conductivity ($10^6\ \mu S/\mu m$)")
plt.suptitle("Conductivity distribution")
plt.show()
```



In [5]:
```
fig = plt.figure(layout='constrained')
ax = fig.subplots()

for i, size in enumerate(SIZES):
    plt.scatter(df[f"{size} size"], df[f"{size} cond"], color=COLORS[i], s=
5)

ax.set_yticks(np.linspace(min(df[f"{SIZES[0]} cond"]), max(df[f"{SIZES[-1]}
cond"]), 8))
ax.yaxis.set_major_formatter(mpl.ticker.FuncFormatter(lambda x, pos: f"{x*1
e-6:.2f}"))
ax.set_xticks(SIZES)
plt.xlabel(r"Grain Size ($\mu m $)")
plt.ylabel(r"Conductivity ($10^6\ \mu S/\mu m$)")
plt.suptitle("Grain size vs. Electrical Conductivity")
plt.show()
```



In [6]:
```
fig = plt.figure(layout='constrained')
ax = fig.subplots()

plt.plot(df.iloc[:,::2].mean(), df.iloc[:,1::2].mean(), "--", alpha=0.6, co
lor=COLORS[-1], linewidth=1)

for i, size in enumerate(SIZES):
    plt.errorbar(df[f"{size} size"].mean(), df[f"{size} cond"].mean(),
                 xerr=df[f"{size} size"].std(), yerr=df[f"{size} cond"].std
(),
                 marker='o', capsize=3, markersize=np.log(size) * 4 / np.lo
g(SIZES[-1]), color=COLORS[i])

ax.set_xticks(SIZES)
plt.xlabel(r"Grain Size ($\mu m $)")
plt.ylabel(r"Conductivity ($10^6\ \mu S/\mu m$)")
plt.suptitle("Mean Grain size vs. Mean Conductivity")

plt.show()
```