



APPLICATION OF FEMTOSECOND LASER FABRICATED MULTI-SCALE STRUCTURES IN ELECTROLYSIS AND HEAT TRANSFER



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Motivation

- Use of femtosecond laser fabricated multi-scale structures to control material surface properties including:
 - Wettability
 - Optical Properties
 - Mechanical Properties

- Example of wettability control:



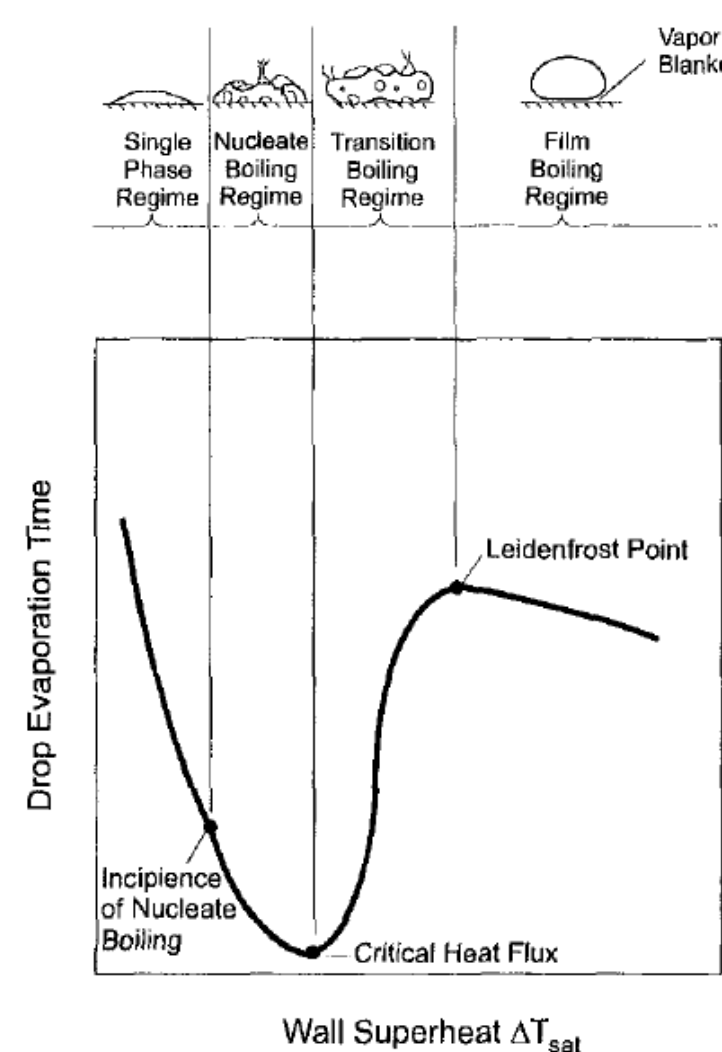
- Applications of surface treatment:

Electrolysis

- Decrease power consumption of electrolysis process
- Increase brown gas production

Heat Transfer and Droplet Applications

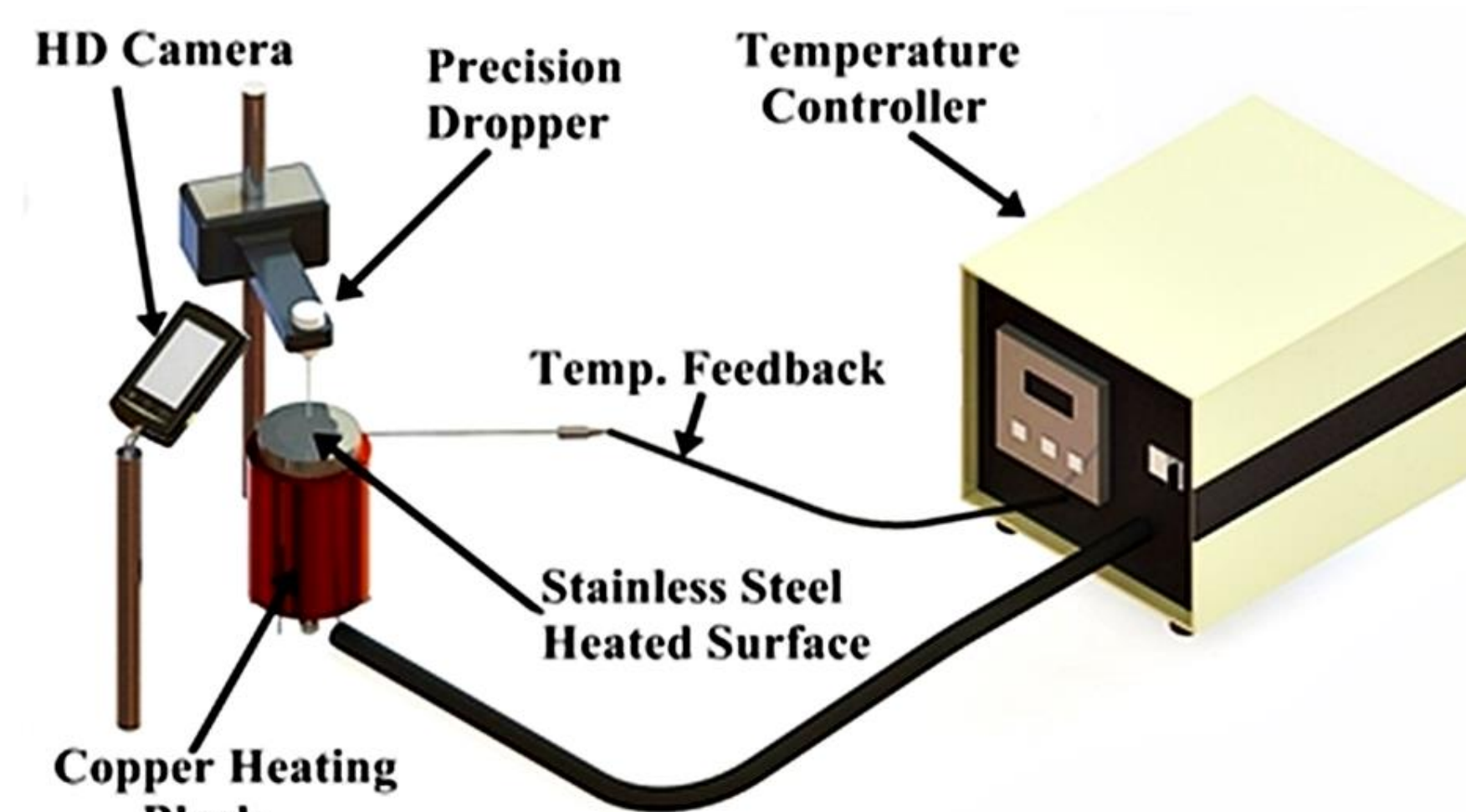
- Increase temperature range of efficient nucleate boiling regime
- Increase efficiency of cooling hot metals in metallurgical and power plant industry
- Leidenfrost droplet motion can be controlled and used for various transport applications



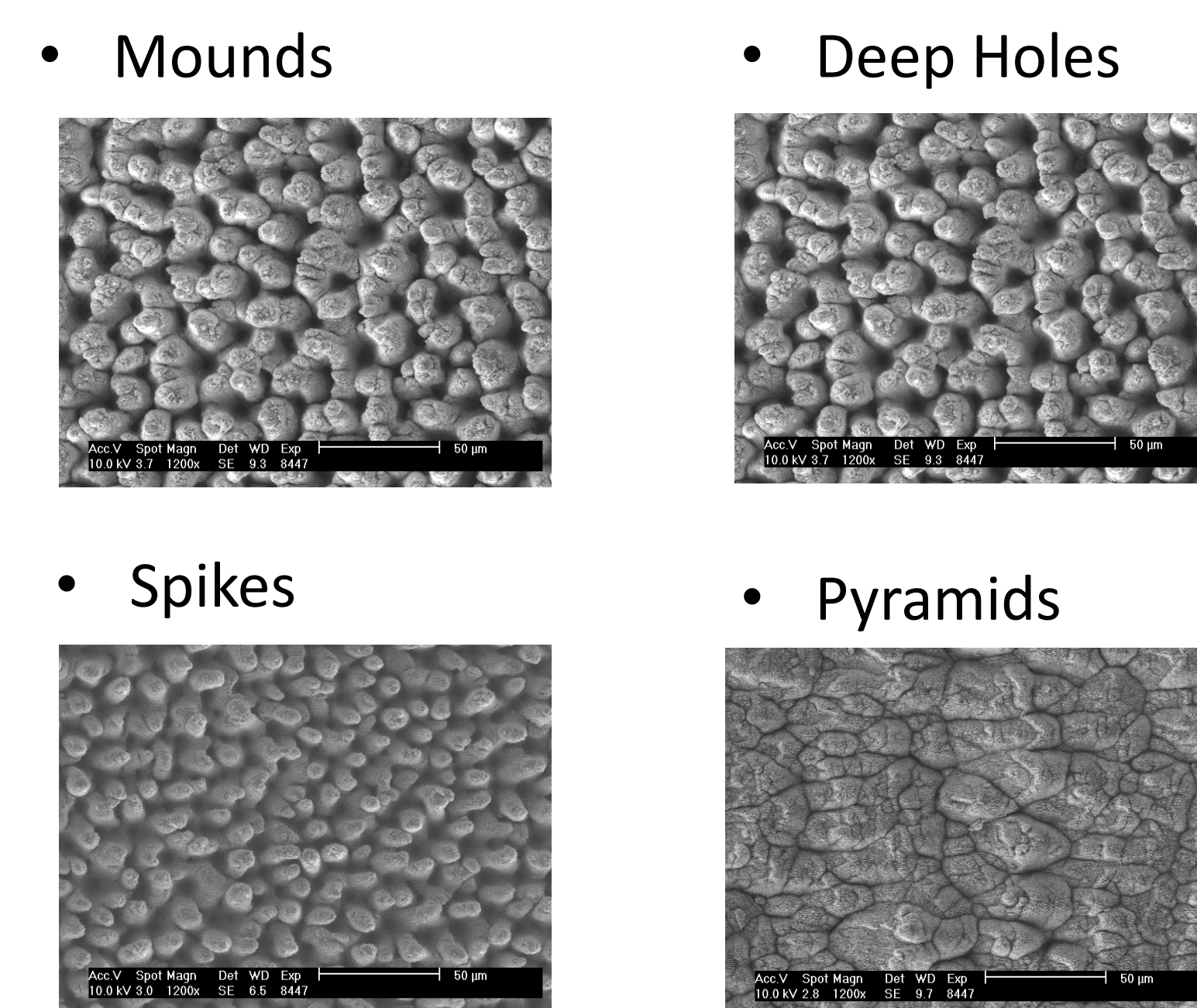
Heat Transfer

Experimental Setup

- Precision Rame-Hart automated dropper system
- Precision controlled heating surface (.1 °C resolution)
- Droplet evaporation time recorded vs. surface temperature
- Sample Material: 304 SS

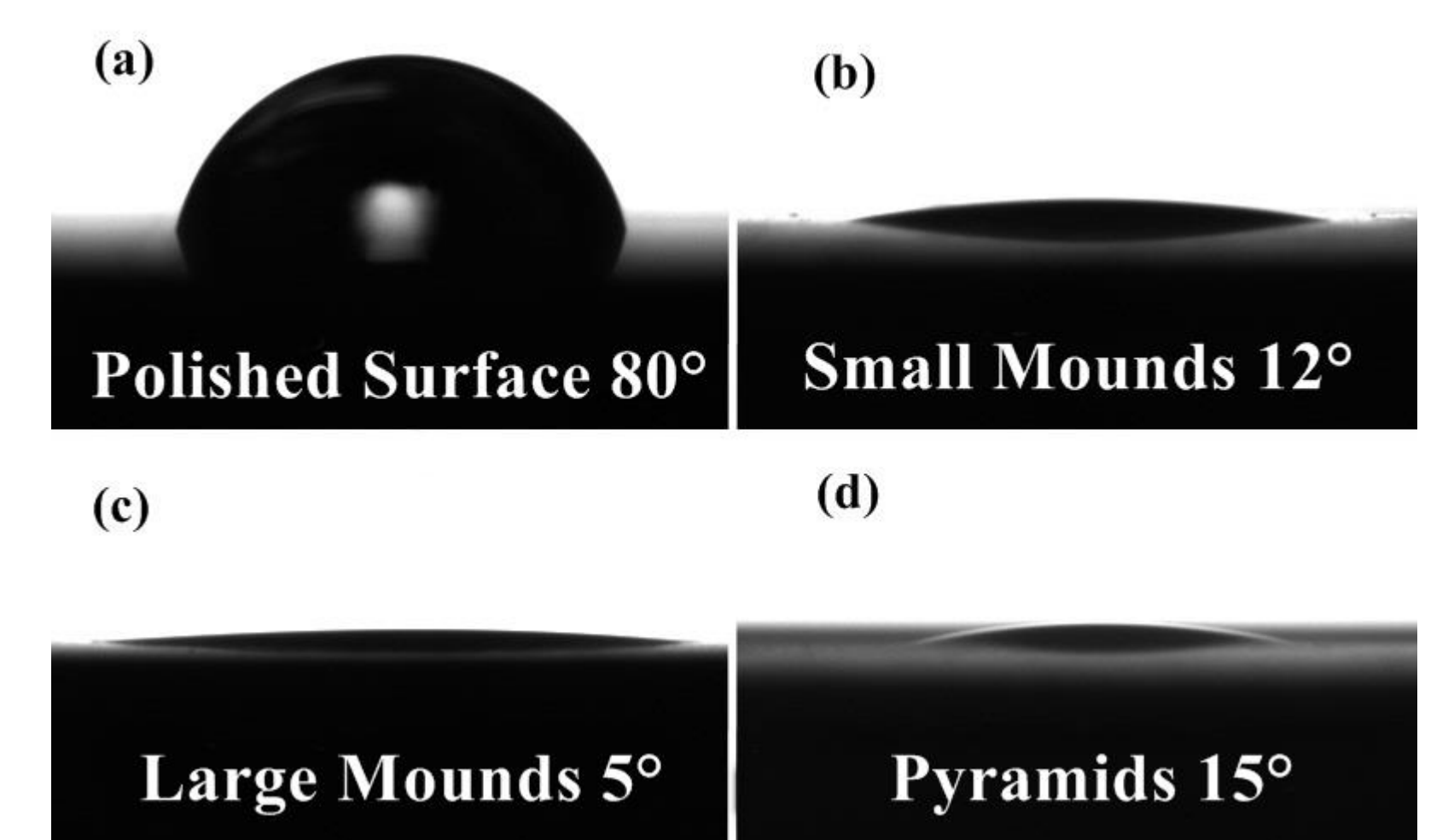
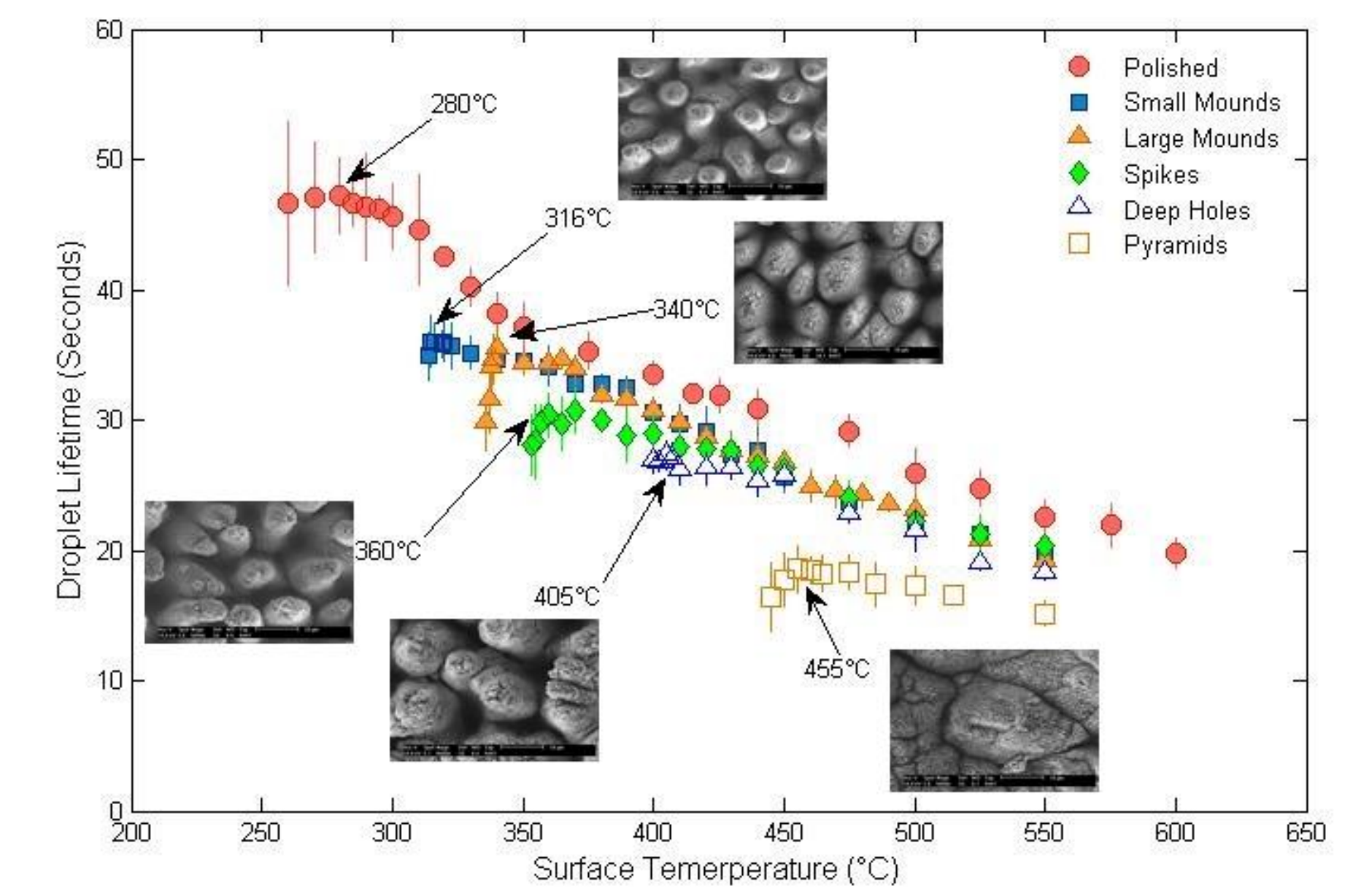


Surface Structures



Results

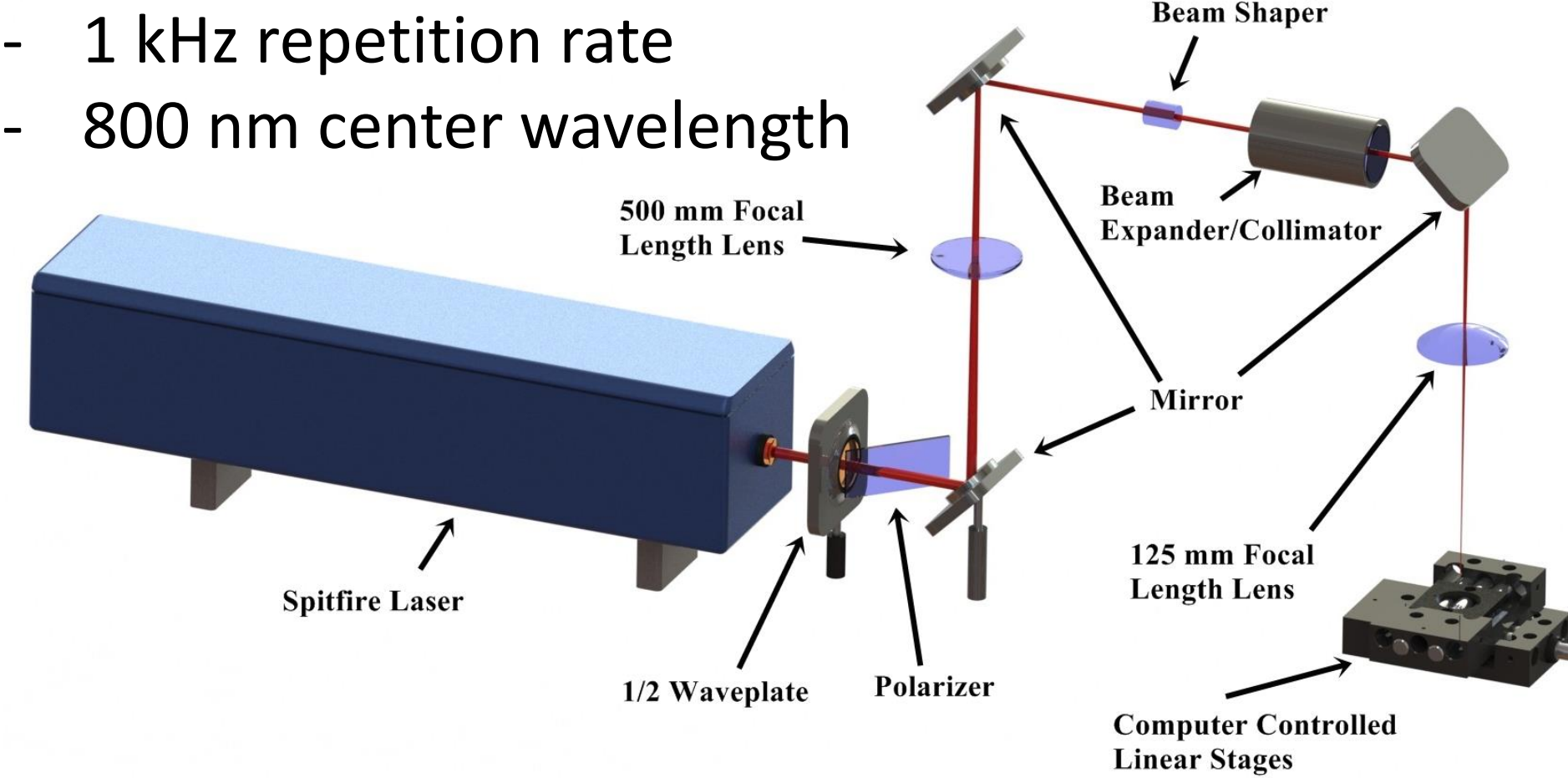
- Extraordinary Increase Leidenfrost Temperature, up to 175°
- Decrease droplet evaporation times by 33% at 500 °C
- Decreased contact angle significantly (minimum of 0°)



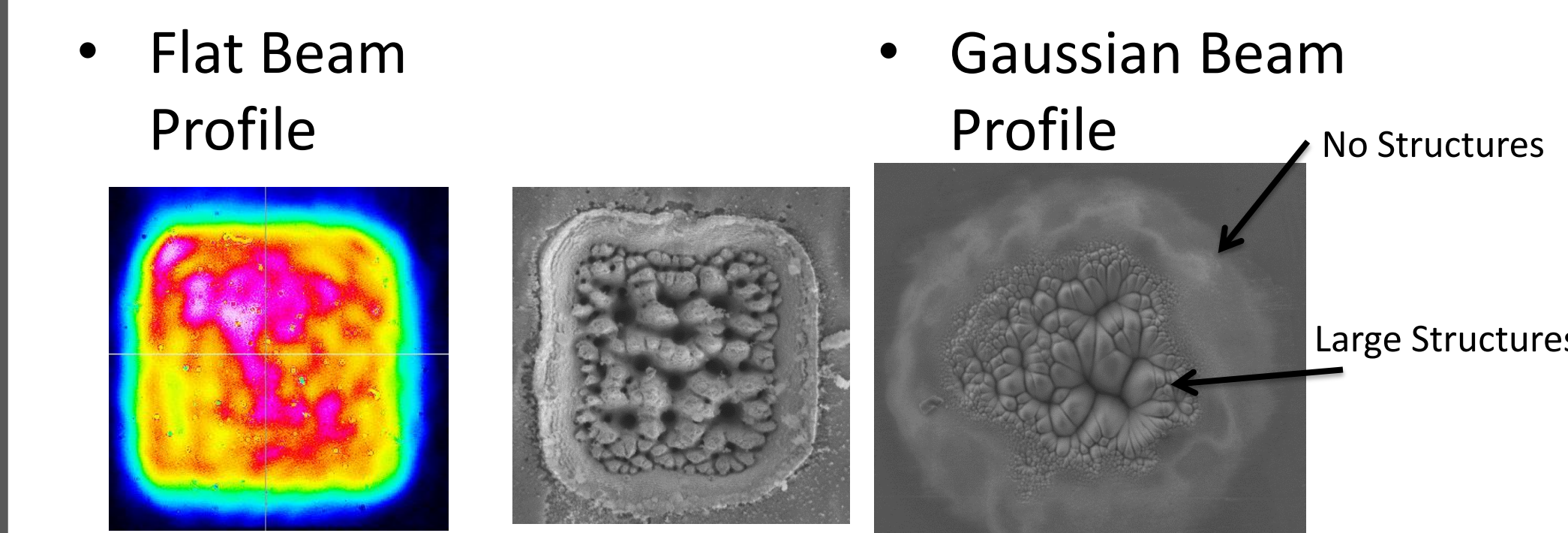
Nano and Microstructure Fabrication

Machining Process

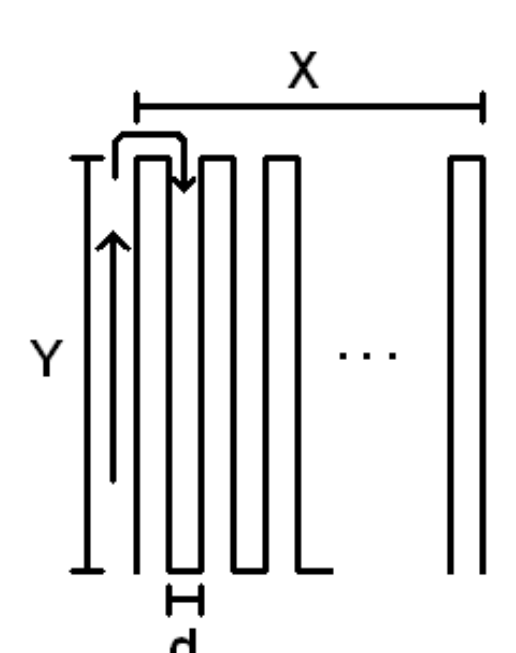
- Spectra-Physics Spitfire Laser
 - 50 fs
 - 1 mJ maximum pulse energy
 - 1 kHz repetition rate
 - 800 nm center wavelength



- Flat top beam profile
 - More control over structure distribution



Raster Path On Sample

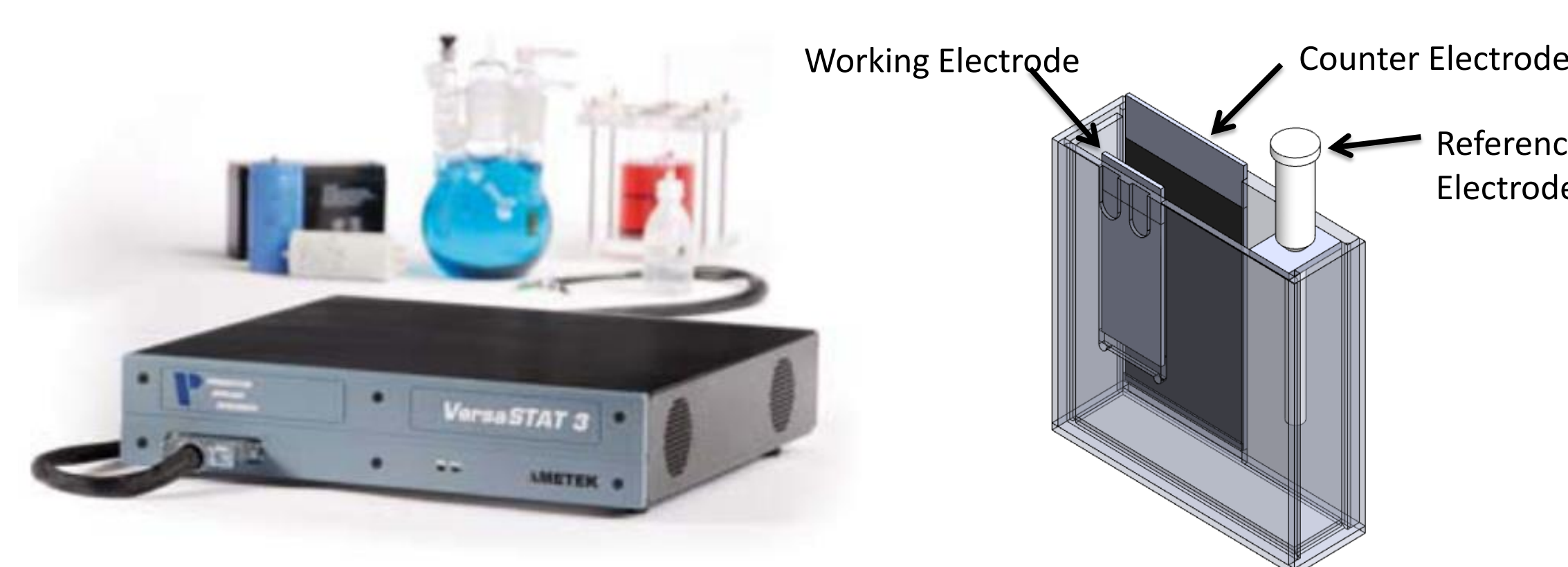


- Nanoparticle redeposition and surface fluid flow create micro and nano-structures.

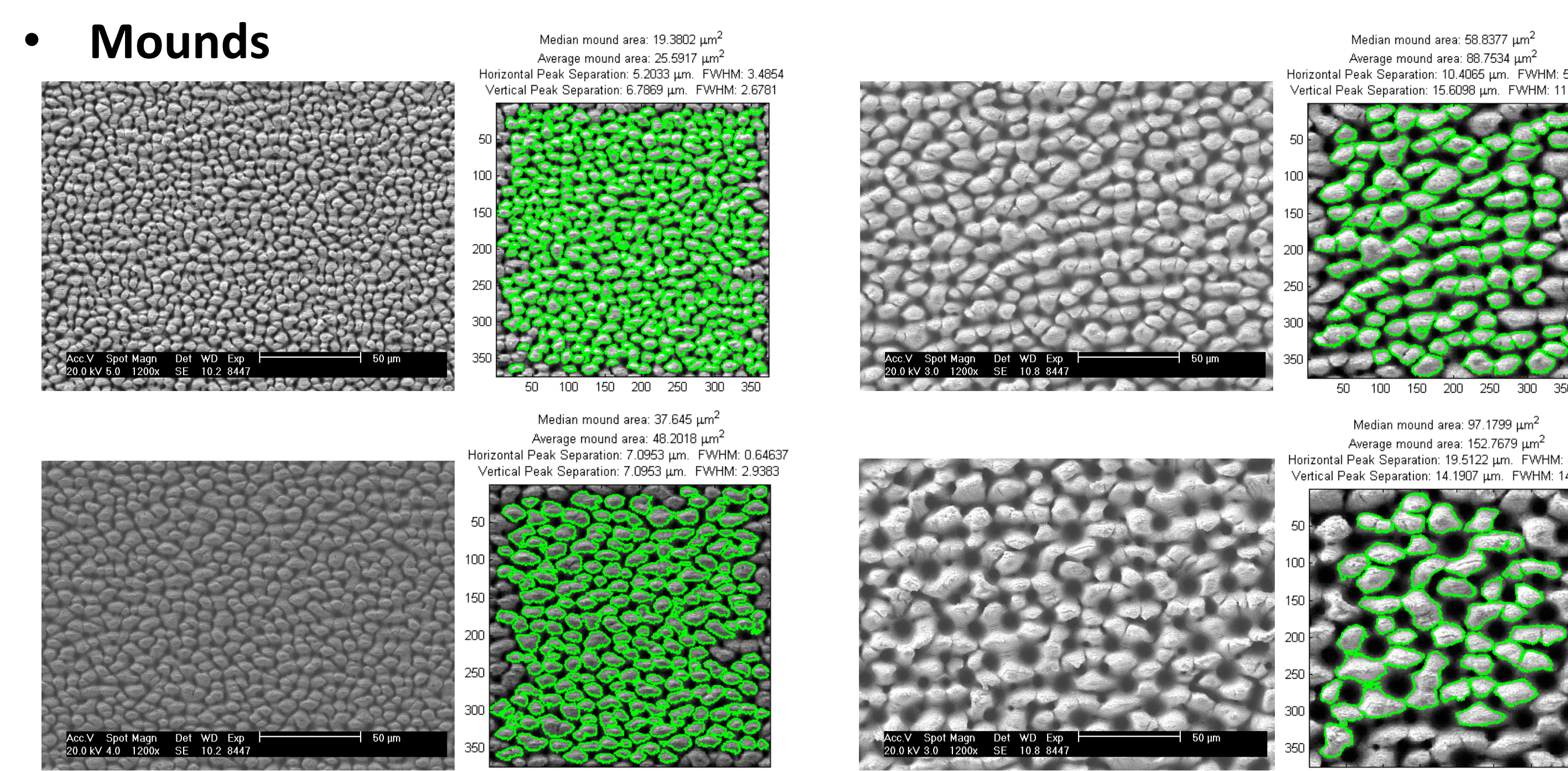
Electrolysis

Experimental Setup

- Custom 3 terminal electrochemical cell
- Princeton Applied Research VersaSTAT 3 - Voltage control and current monitoring
- 1M KOH electrolyte
- Sample Material: 316 SS

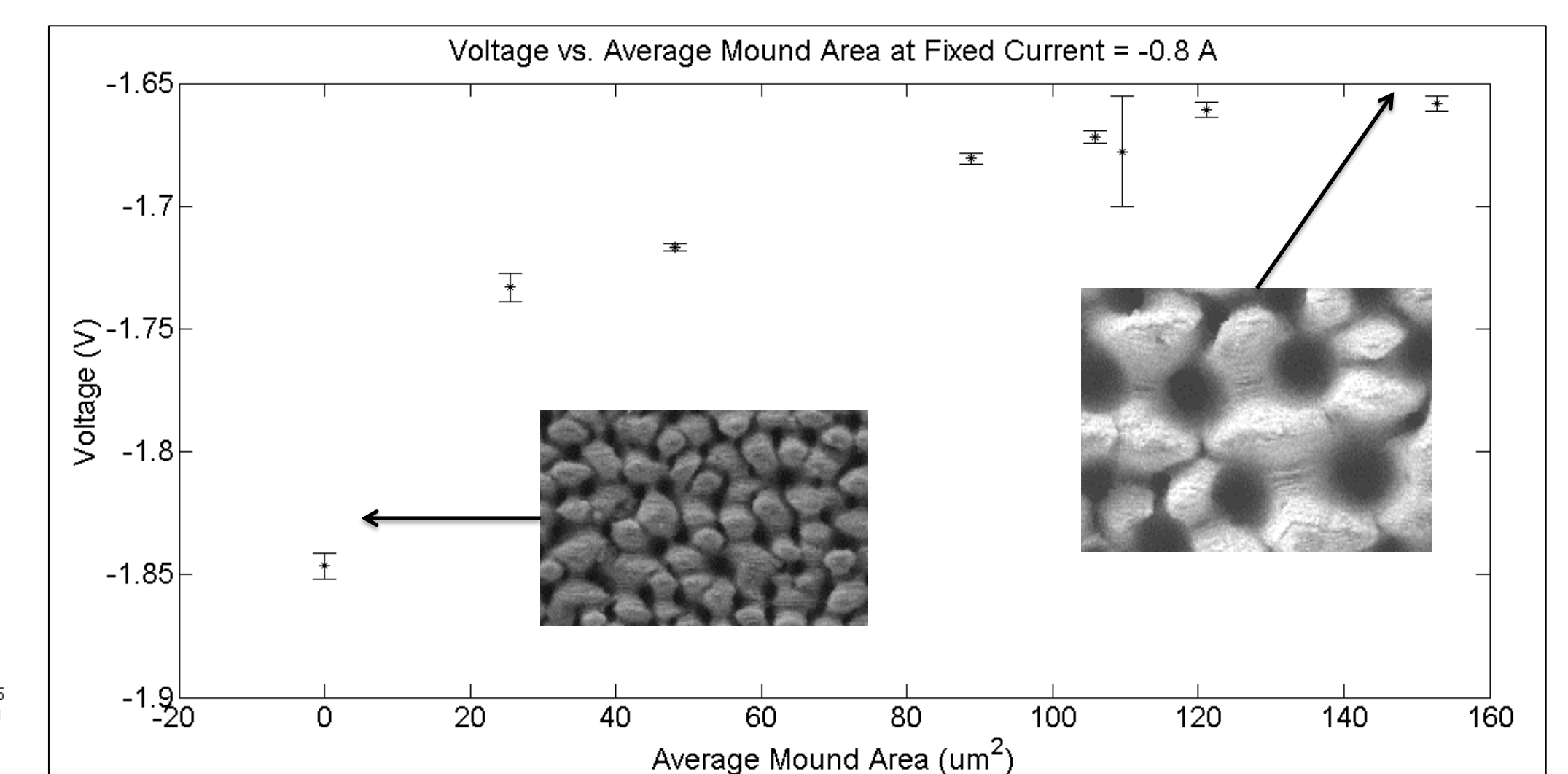
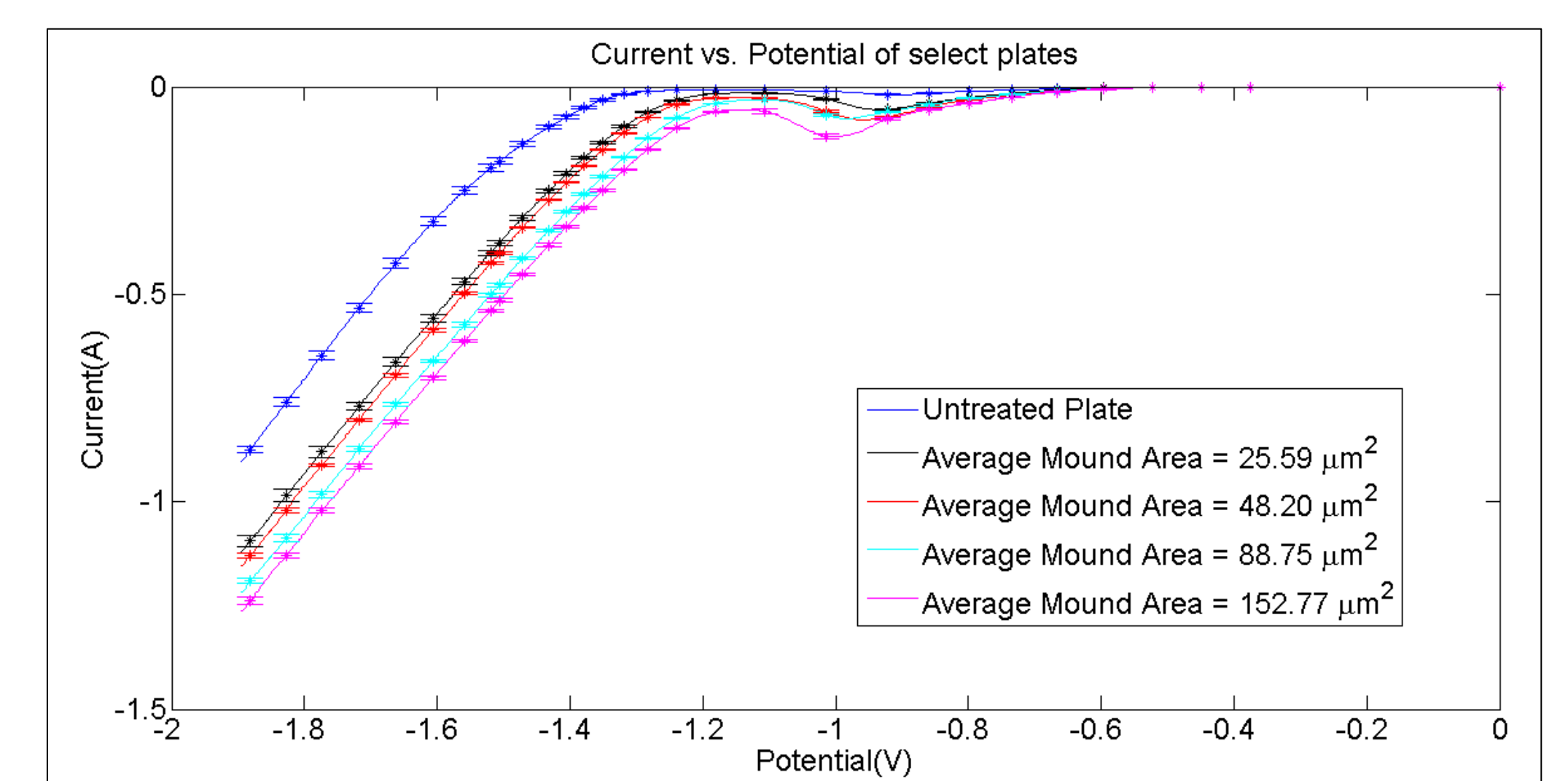


Surface Structures



Results

- Increase in average mound area directly decreases power consumption
- 10.46 % maximum reduction to date



Acknowledgements

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