Superhydrophobic surfaces are of much interest to many industries due to the various thermodynamic properties they possess. Hydrophobic in the most basic nature means “water-fearing.” Consequently, these surfaces undergo a more extreme version of this because of a textured surface that will allow for dropwise condensation which allows for water droplets to coalesce and “jump” off the surface. Due to the droplets ability to jump away, these surfaces have the opportunity to be applied to heat transfer, anti-icing, and anti-droplet purposes. This is inherently important in the energy industry as heat transfer operations are a daily part of normal plant procedures. Studying different mechanisms about how to form these surfaces allows for the advancement of how different substrates and different coatings can help improve these properties to widen industry application.

GOALS AND ACTION PLANS

- Fabricate Copper (II) Oxide and Aluminum Oxide surfaces
- Use current procedures to form superhydrophobic surfaces and
- Analyze drop-wise condensation on surfaces
- Learn micro-goniometer techniques and analyze contact angles to determine effectiveness of coating
- Design and test new chemical mechanisms
- Fabricate superhydrophobic surfaces on metals of interest including titanium, carbon steel, and stainless steel

METHODS

- Samples are cleaned and sonicated in organic solvents. A cleaning in \( \sim 2.0 \text{ M HCl} \) is done as well to remove existing oxide layers.
- Alkaline solution is produced using sodium hydroxide (NaOH), sodium hypochlorite (NaClO), and sodium phosphate tribasic dodecahydrate (Na\(_3\)PO\(_4\) \( \cdot \) 12H\(_2\)O).
- After samples are placed in the solution, they are rinsed in organic solvents and water. They are then dried with N\(_2\). Vapor deposition is then used to deposit HTMS onto the surface (not pictured).

RESULTS AND DATA ANALYSIS

Figures above are SEM images of the surfaces tested. Figure III exemplifies the structures most desired for superhydrophobicity as there are many “crevices” that create roughness on the surface. Titanium showed roughness without any chemical treatment, indicating some hydrophobicity. Coated titanium, using the current process, showed increased order and magnitude of this roughness thus increasing the testing potential of titanium. Photos Courtesy of Soumyadip Sett

FUTURE DIRECTIONS AND CONCLUSIONS

Main Mechanism: Surface Roughness + Low Surface Energy Material = Superhydrophobic Surface

This project has many future directions that intend to be investigated in the near future. Current research done with designing chemical mechanisms is turning towards chemical etching for the creation of micro/nano-structures on surfaces. Electrochemical etching has been shown to provide the most promise in both effectiveness and safety. Industrial upscale would also be very possible with electrochemical methods as the reagents involved do not present much danger to people or the environment. These methods have been investigated for titanium; however, further testing of cathode materials and different substrates will be conducted to further explore chemical etching. Low surface energy materials will be investigated for this process as well.

REFERENCES