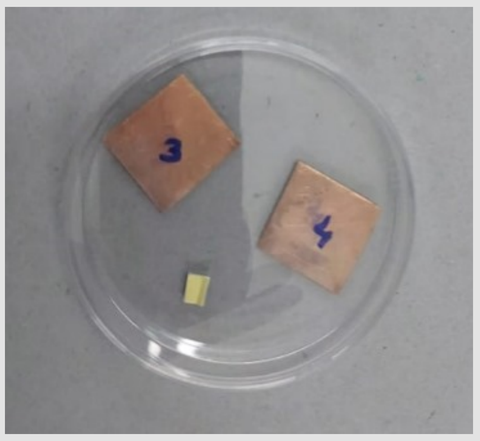
Developing Nanoengineered Surfaces for Thermal Management

Shrey Agarwal | Purva Shah | Atharva Bodhale | Shivrajsinh Bhosale| Kavya Gotecha
Department of Chemical Engineering | Materials Engineering
Prof. Soumyadip Sett, Department of Mechanical Engineering
Indian Institute of Technology Gandhinagar, Gujarat

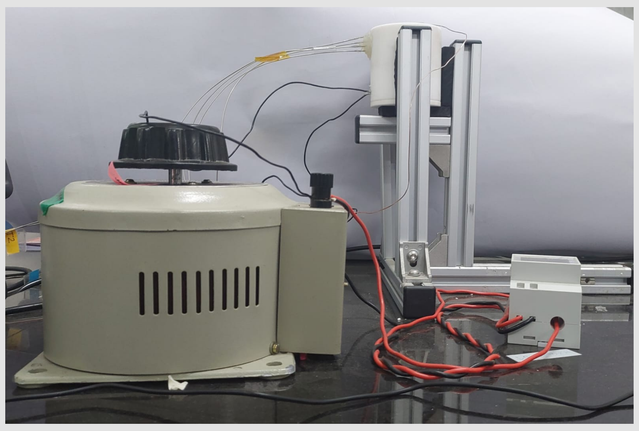
Introduction

This study investigates the heat transfer properties of TiB2-coated nano-sheets on copper substrates, evaluating their potential as efficient heat spreaders and exploring their antifouling characteristics. Through a series of experiments, including heat spreading tests, drop evaporation assessments, and antifouling tests (on bare Cu) conducted under various voltage conditions, we compare the thermal performance and fouling resistance of TiB2-coated nano-sheets on copper with bare copper counterparts.

Experimental setup



TiB2 coated and bare Cu samples



Heat Spreader and Drop Evaporation Experiment Setup

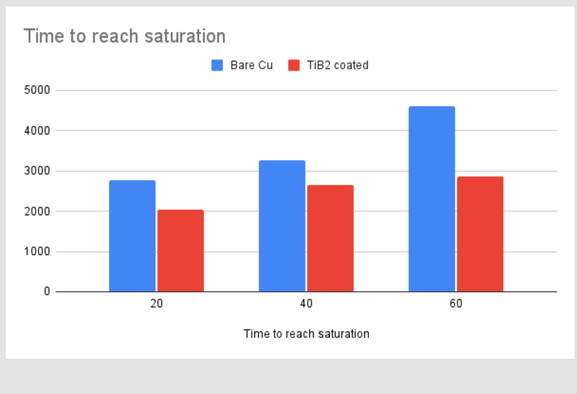
Methodology

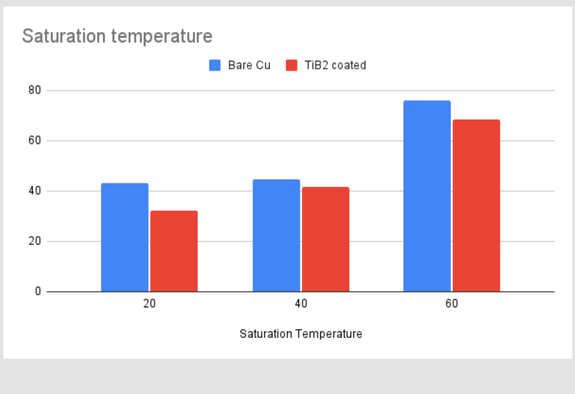
1. Fabricated 8 TiB2 coated copper nanosheets.
2. Conducted heat transfer experiments such as:
   a. Heat Spreading Experiment
   b. Drop Evaporation Experiment
3. Explored anti-fouling properties with different solvents like:
   a. 0.6g of CaSO4
   b. Artificial Sea Water
4. Analysed the trend of saturation temperatures and calculated the heat flux at different voltages.
5. Analyzed the percentage increase in weight due to salt deposition on nanosheets.

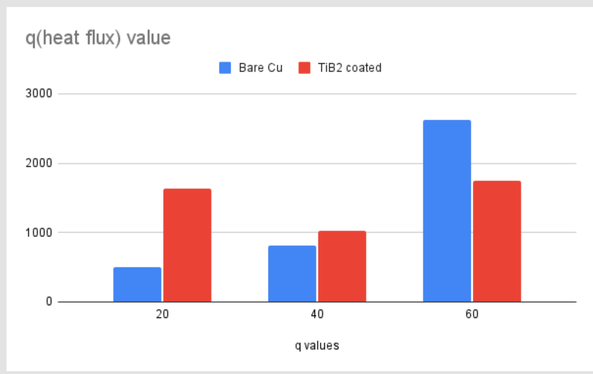
Learnings

1. Coating of bare copper surfaces with TiB2 nanosheets.
2. Conducting Experiments focusing on heat spreading across bare copper, TiB2 nanosheet- coated.
3. Analysing of Dynamic heat dissipation through drop-evaporation experiments conducted on copper surfaces.
4. Data analysis and visualization performed to compare results obtained from different copper surface configurations.

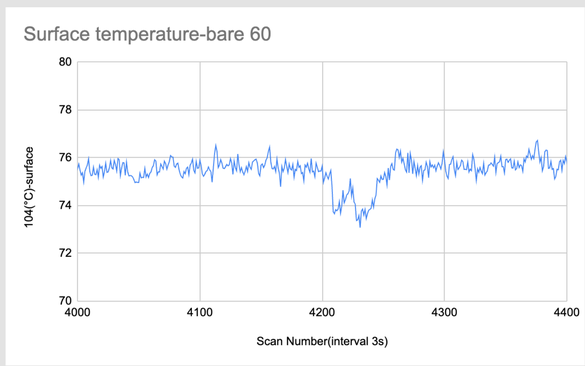
Results

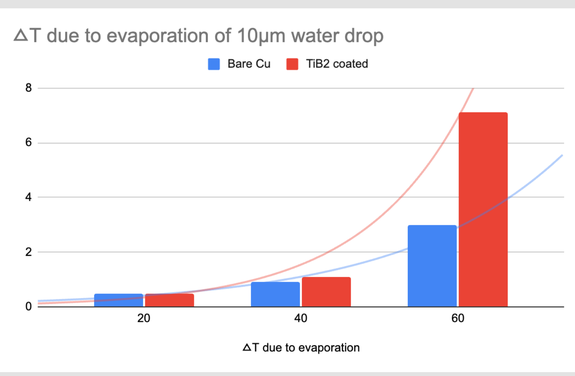


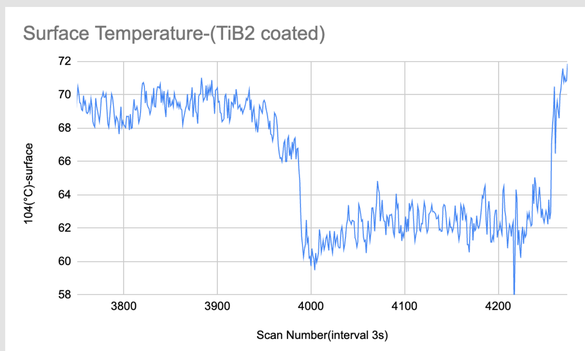




Heating experiments







Evaporation experiments

Future scope

1. Validate and expand upon initial findings.
2. Conduct further comparative antifouling tests to strengthen understanding of TiB2-coated nano-sheets' fouling resistance on copper substrates.
3. Perform additional thermal management experiments to explore diverse applications of these nanosheets.
4. Refine understanding of both thermal properties and antifouling capabilities.
5. Contribute to the development of advanced heat management technologies with broader industrial applications.

Acknowledgements

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References: Heinz, Michael, I. U. Chowdhury, Peter Stephan, and Tatiana Gambaryan-Roisman. "Water drops on nanofiber-coated substrates: Influence of wall temperature and coating thickness on hydrodynamics and wall heat flux distribution." *International Journal of Heat and Mass Transfer* 222 (2024): 125117.