**Summer Research Internship Program - 2024**

# Developing Nanoengineered Surfaces for Thermal Management


**Fig: TiB2 Microstructure**

**Name:** Shivrajsinh Sandip Bhosale

**Intern ID:** 21732291

**Faculty Mentor:** Prof. Soumyadip Sett

## Abstract

This research investigates the heat transfer properties of TiB2-coated nano-sheets on copper substrates. The study evaluates their potential as efficient heat spreaders and explores their antifouling characteristics. A series of experiments were conducted, including heat spreading tests, single drop evaporation assessments, drop area analysis, multiple drop tests, and antifouling tests on bare copper. The performance of TiB2-coated nano-sheets on copper was compared with that of bare copper.

## Objectives

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

## Experimental Setup

The experimental setup consisted of:

- Heat spreading tests
- Single drop evaporation assessments
- Drop area analysis
- Multiple drop tests
- Antifouling tests conducted under various voltage conditions

These tests were designed to measure and compare the thermal performance and fouling resistance of TiB2-coated nano-sheets against bare copper.

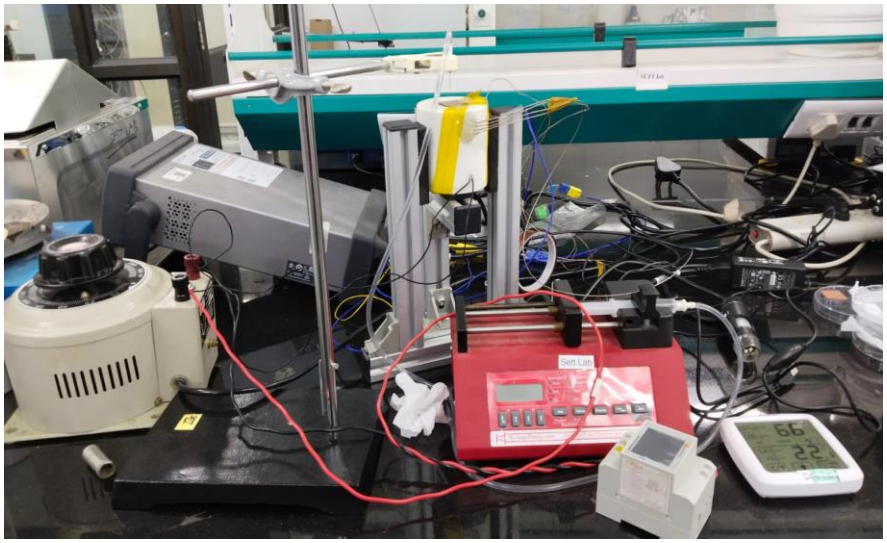

*Fig: Evaporation drop experiment Setup*

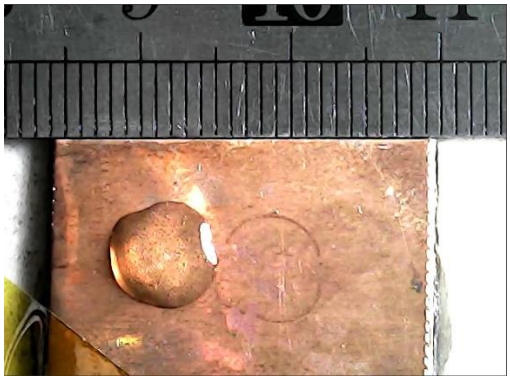

Fig: Determining the evaporation rate

## Results

1. **Heat Spreading Capabilities**: TiB2-coated copper sheets demonstrated substantial heat spreading capabilities when subjected to elevated temperatures, enhancing their thermal performance.
2. **Bubble Evaporation**: The presence of TiB2 coating on sheets resulted in a reduced time requirement for bubble evaporation, indicating improved heat transfer efficiency.
3. **Voltage Variability**: At lower voltages, the behavior of TiB2-coated sheets became unclear, suggesting variability or instability in performance under these conditions.
4. **Flow Rate**: Due to the accelerated water evaporation rate, TiB2-coated sheets required higher flow rates to ensure efficient cooling and maintain optimal thermal management.

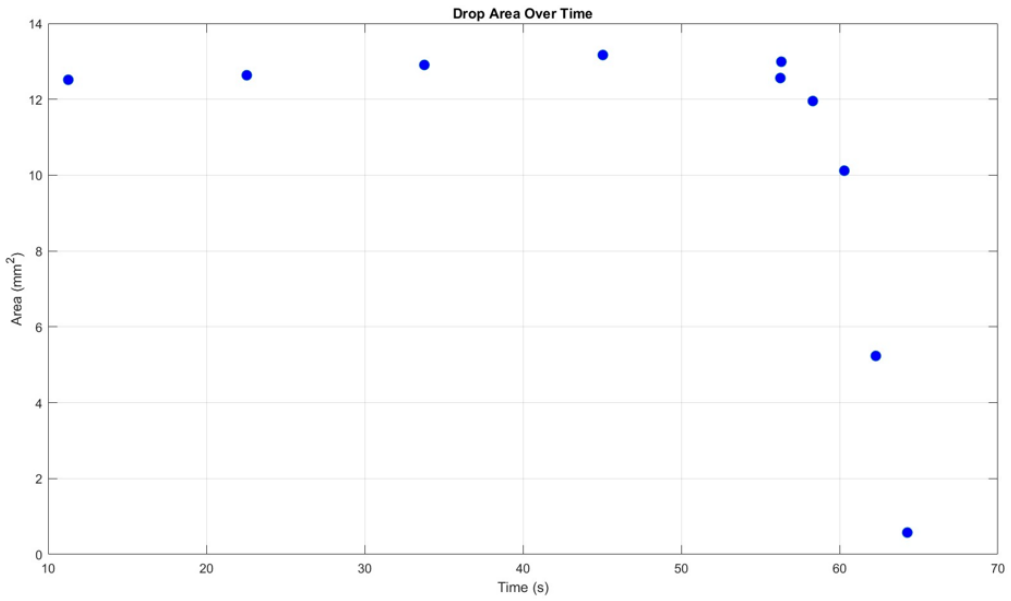


Fig3: Change in bubble area wrt time for 70V (10ul)

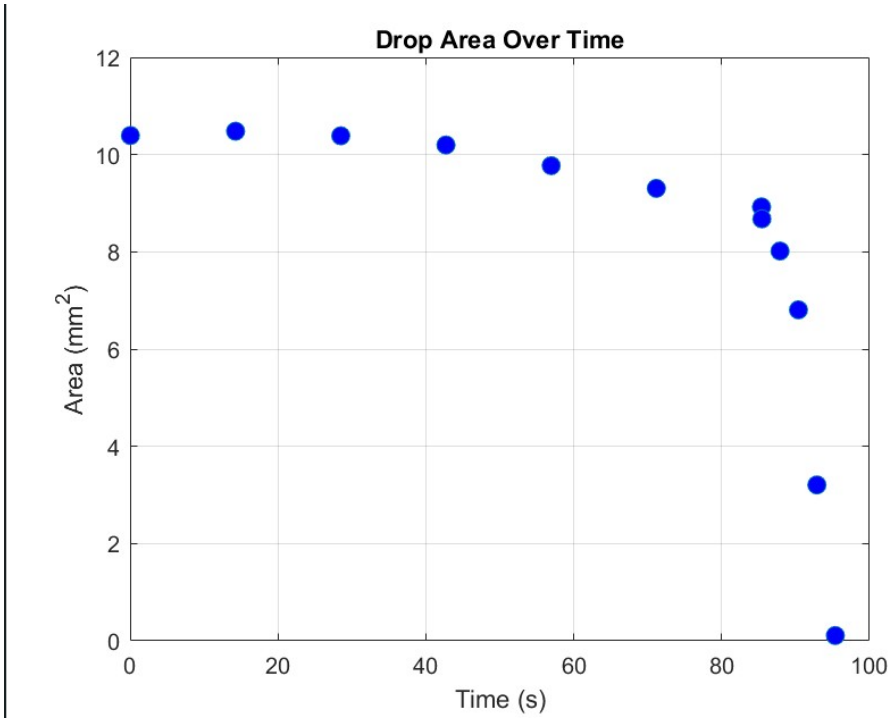


Fig 4: Change in bubble area wrt time for 70V (20ul)

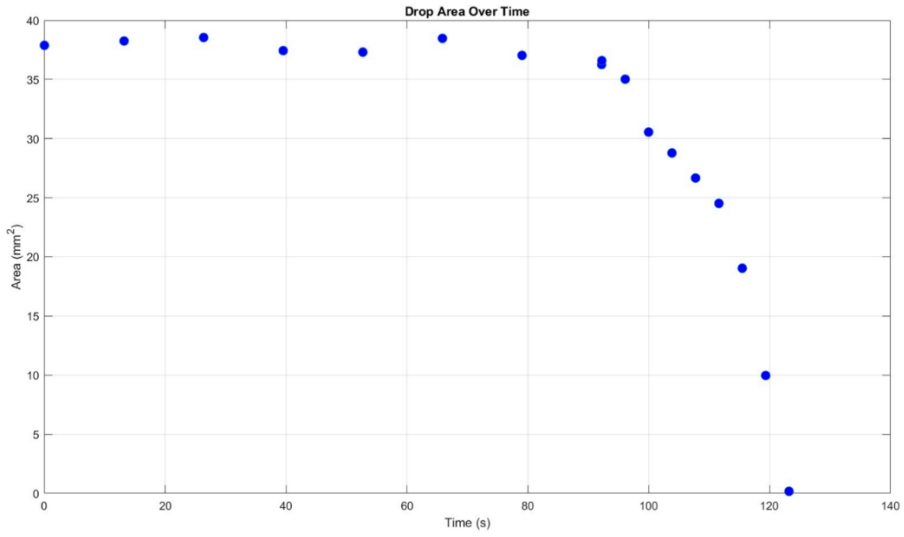


Fig 5: Change in bubble area wrt time for 50V(10ul)

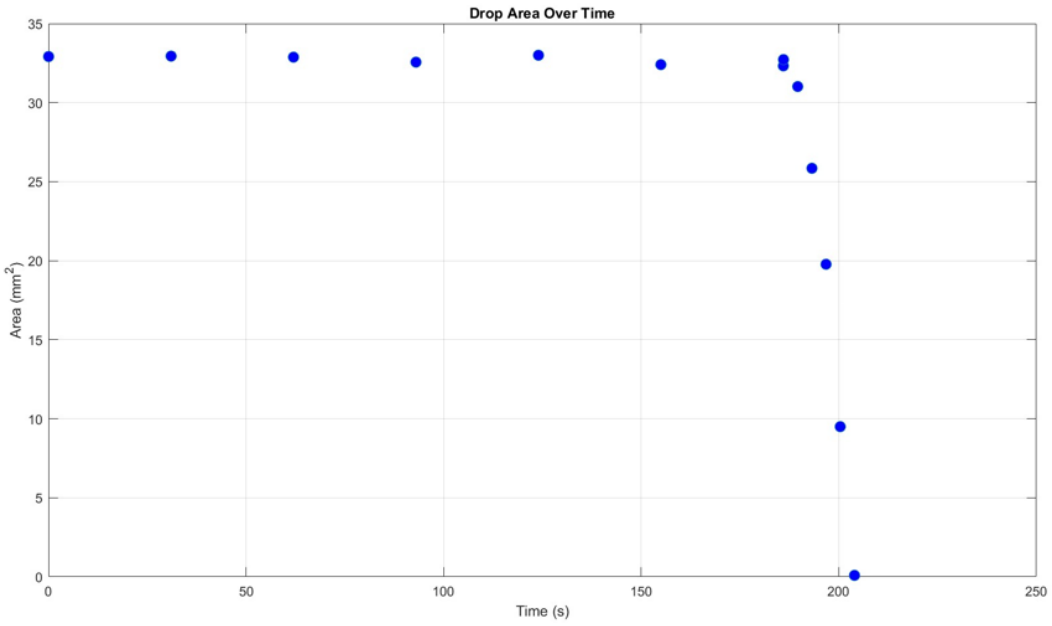


Fig 6: Change in bubble area wrt time for 50V (20ul)

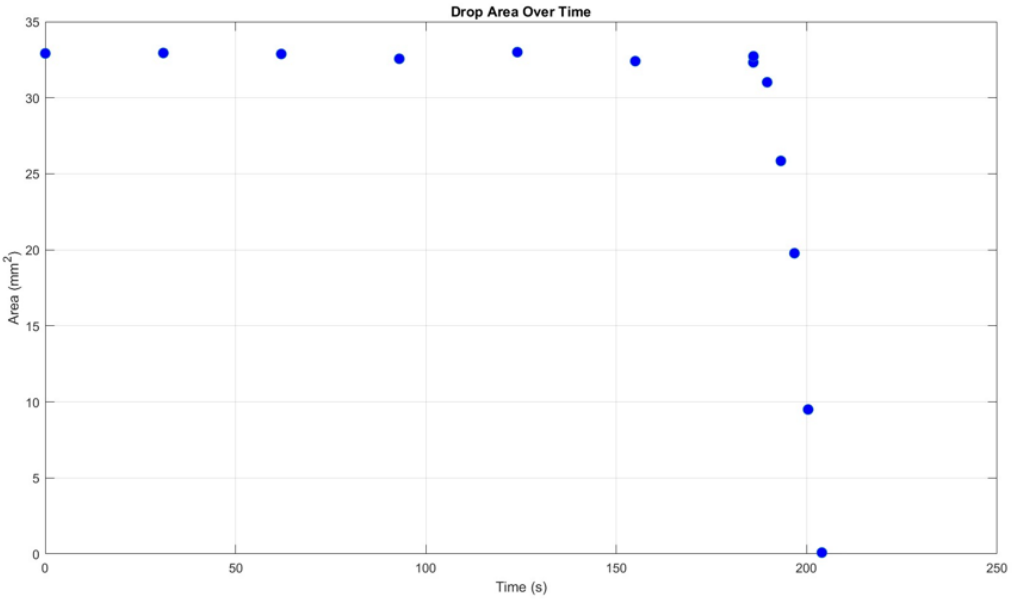


Fig 6: Change in bubble area wrt time for 50V (20ul)

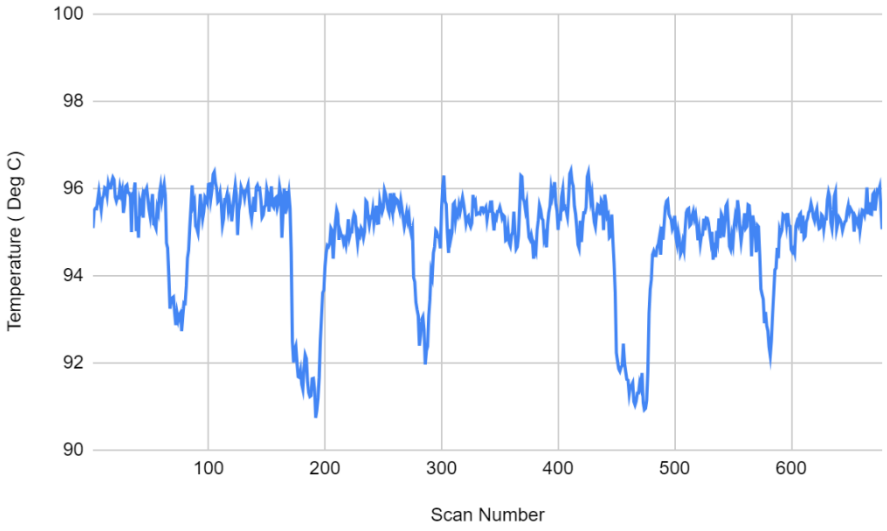


Fig 8 : Bare 70V at a flow rate of 4ul

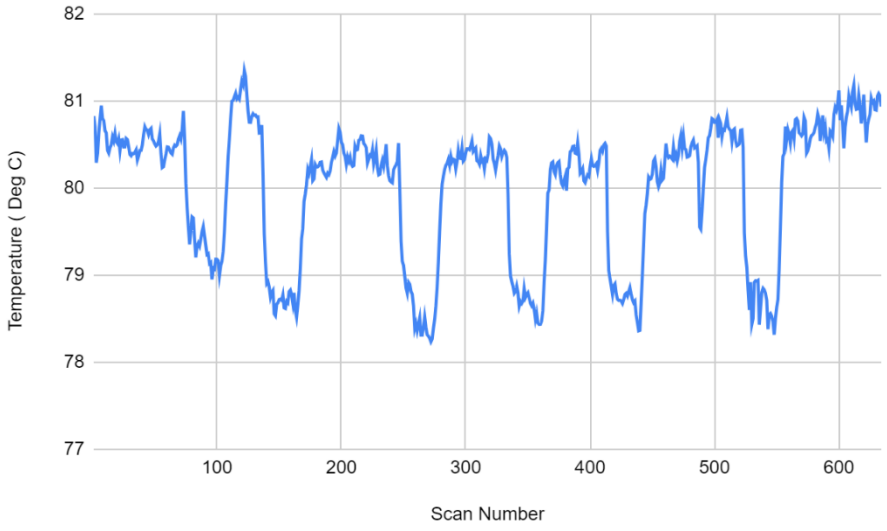


Fig 9 : Tib2 60V at a flow rate of 4.5ul

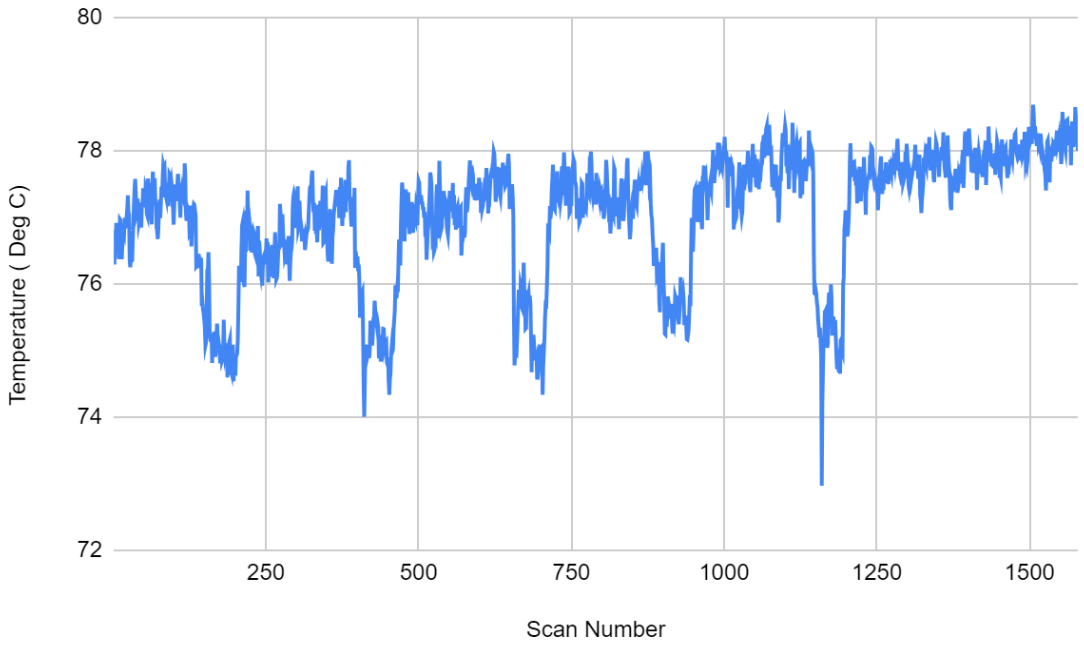


Fig 10 : Bare 60V at a flow rate of 3.5ul

## Conclusions

The study confirmed the enhanced thermal performance of TiB2-coated nano-sheets on copper substrates. The findings suggest that these coatings can significantly improve heat transfer efficiency and offer promising antifouling properties. However, variability at lower voltages indicates the need for further investigation.

## Future Scope

The research team plans to:

1. Conduct further antifouling tests to reinforce the understanding of the fouling resistance of TiB2-coated nano-sheets.
2. Explore additional thermal management experiments to diversify the applications of these nanosheets.
3. Refine the understanding of the coatings' thermal properties and antifouling capabilities.
4. Contribute to advancing heat management technologies with broader industrial applications.

### Acknowledgment

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**References**

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