DEVELOPING NANOENGINEERED SURFACE FOR FOULING/ANTIFOULING PROPERTIES

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ABSTRACT

This research investigates the fouling and antifouling properties of nanoengineered surfaces. Experiments were conducted on bare copper and copper coated with various nanosheets, including HTMS, Fullerene, TiB_2, CuO, CuO + HTMS, and LIS. The materials were exposed to a $CaSO_4$ solution at a concentration of 1 g/L and temperatures between 70-75°C to observe the fouling behavior. The primary objective is to evaluate and compare the fouling resistance of these nanosheet coatings on copper. The findings of this study aim to contribute to the development of advanced antifouling surfaces through nanoengineering techniques, enhancing material performance in relevant applications.

INTRODUCTION

Fouling is a phenomenon where unwanted materials, such as scale, biological organisms, or particulates, accumulate on solid surfaces. This accumulation can lead to significant challenges across various industries, including water treatment, marine engineering, and heat exchanger systems. Copper, widely used for its excellent thermal and electrical conductivity, is particularly susceptible to fouling when exposed to diverse environments. The buildup of fouling materials degrades the material's performance, increases maintenance costs, and leads to operational inefficiencies.

OBJECTIVE

To mitigate these issues, this research focuses on enhancing the fouling resistance of copper through the application of nanosheet coatings. Nanosheets, with their unique surface properties and high surface area-to-volume ratio, present promising antifouling capabilities. In this study, we investigate the fouling and antifouling properties of both bare copper and copper coated with various nanosheets, specifically HTMS, Fullerene, TiB_2, CuO, CuO + HTMS, and LIS.

METHODS

Samples fabricated:

- HTMS coated copper
- TiB_2 coated copper
- CuO coated copper
- CuO + HTMS coated copper
- Fullerene coated copper
- LIS copper

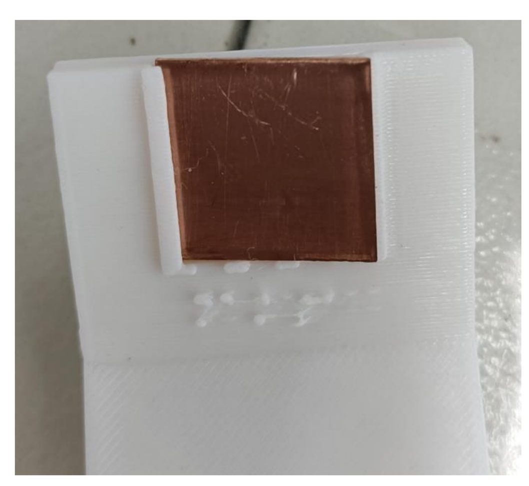
Conducted fouling experiments on the samples in 1g/L $CaSO_4$ solution.

Analysis:

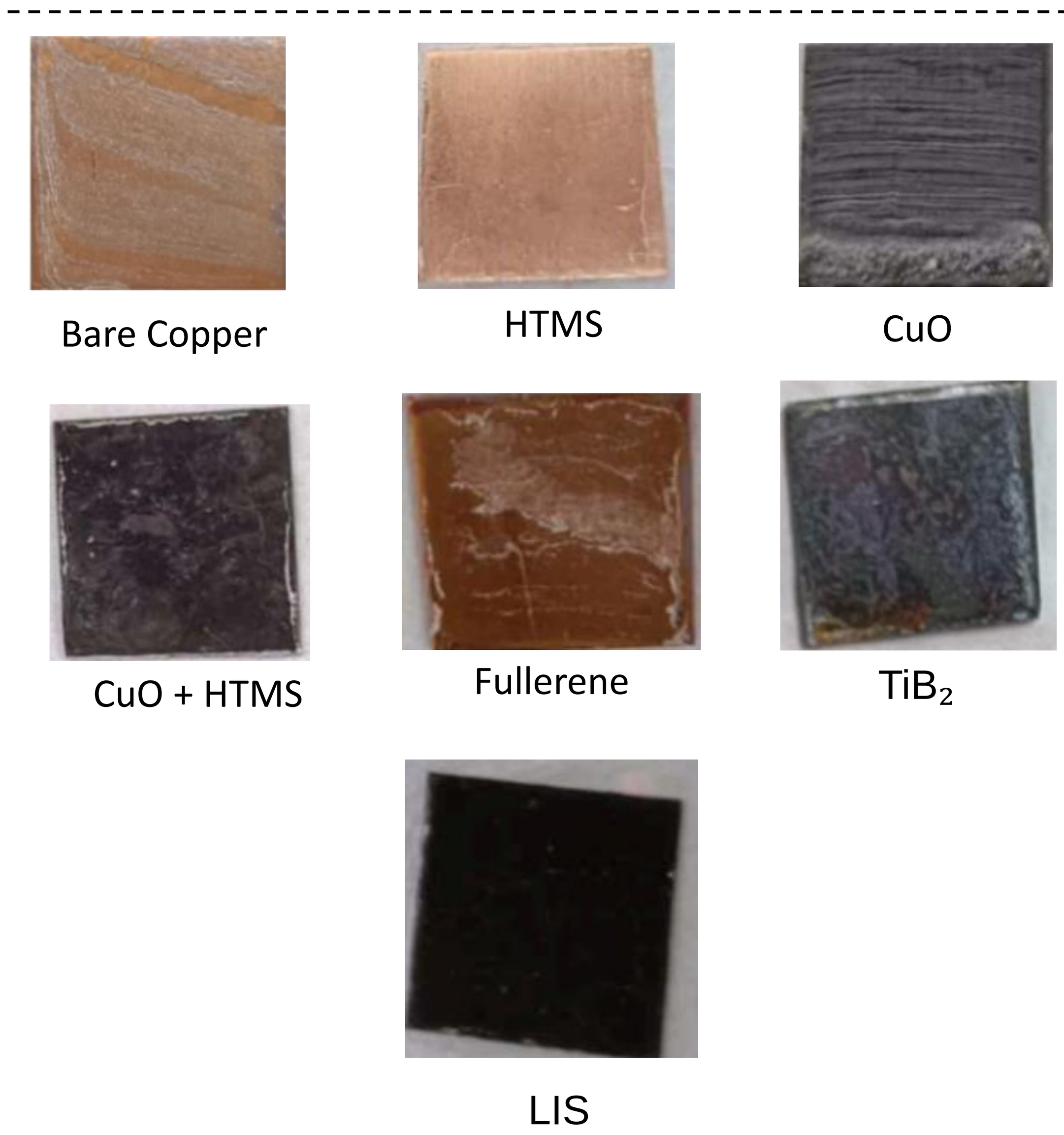
- Calculated the fouling percentage of each sample.
- Compared the fouling percentages of each coated sample relative to bare copper.

OBSERVATIONS AND RESULTS

Sample	Fouling (%)
Bare Copper	100
HTMS	60-70
CuO	130-180
CuO + HTMS	30-40
TiB_2	200-300
Fullerene	95-105
LIS	0-1


Bare Copper before fouling


Bare Copper after fouling



Fouling behavior of different copper samples

From the data above we can see that The most fouled sample was TiB_2 and the least fouled sample was the LIS. And although LIS has fouled, we were still not able to see its weight in the fouling.

ERRORS AND LIMITATIONS

1. Even though the whole surface of copper was fouled, but its fouling weight was very less.
2. The fouling on bare copper was insufficient; therefore, even though LIS fouls, its percentage is almost near zero.
3. The weighing balance can measure only in milligrams and cannot measure weights smaller than that.
4. We need to optimize the setup so that the fouling can be increased.
5. Even with an increase in concentration, the fouling is not increasing sufficiently.
6. The salt $CaSO_4$ could have crystallized.
7. There can be some salt particles left in the solution which could not have mixed.

CONCLUSION

We observed that the fouling on bare copper was insufficient, impacting the overall accuracy of our measurements. Notably, the Liquid-Infused Surface (LIS) demonstrated the least amount of fouling across all samples tested so far. Our weighing balance can only measure in milligrams, which limits the precision of our measurements and affects the reliability of the data collected.

The major issue with $CaSO_4$ is that even if we increase the concentration of the solution, the fouling on the surface did not increase significantly. The maximum solubility of $CaSO_4$ is around 2g/L. Another possibility is that the salt could have become hydrated and crystallized, reducing its fouling capability.

When we changed the solution from $CaSO_4$ to artificial seawater, the fouling increased, suggesting that a more complex solution might enhance fouling characteristics.

To improve the accuracy of our fouling measurements, it is essential to optimize the experimental setup. This optimization aims to increase the degree of fouling observed. However, despite current adjustments in concentration, the fouling has not significantly increased, indicating a need for further optimization of the experimental conditions. By enhancing the setup, we hope to achieve more accurate and reliable quantification of fouling in various samples. Future work will focus on refining these conditions to better understand the antifouling properties of the tested surfaces.

REFERENCES

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