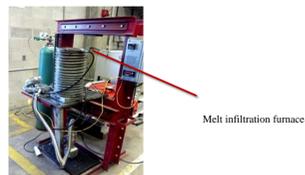


Introduction

- In this experiment pressure infiltration of liquid Aluminum (Al) and graphene with the incorporation of coarse Nickel (Ni) spheres was explored.
- Without nickel additions, graphene bed could not be infiltrated due to lack of wetting and small inter particle spacing.
- Additions of graphene lead to decrease in wettability and increase in corrosion resistance..



Objective

- Infiltrate Al 356 alloy with graphene dispersed in Nickel spheres to provide an even and unique microstructure.
- Additions of graphene lead to decrease in wettability and increase in corrosion resistance.
- This microstructure leads to a surface with low water wettability resulting in even distribution of graphene in the matrix.

Experimental procedures

- Nickel spheres (0.05 g) and graphene (0.05 g) was milled until fully incorporated.
- Glass tube for housing is coated with Zirconia wash (1B) and placed in low temp furnace at 80 Celsius for one hour
- Inside of glass tube is sprayed with graphite.
- Nickel and Graphene mixture is placed in the tube (1A) with felt top placed on top. (1D)
- Aluminum A356 sample (10 g) placed in tube. (1C)
- Sample was then pressure infiltrated at 750-900 degree Celsius for 30 minutes at 300 psi



Figure 1A: Graphene and nickel powder in glass tube with graphite coating. 1B: This layer of Zirconia wash on the outside of tube. 1C: Aluminum sample used for infiltration. 1D: Felt circle placed inside glass tube to prevent graphene or Nickel powders from being lost.

Results

Surface characterization

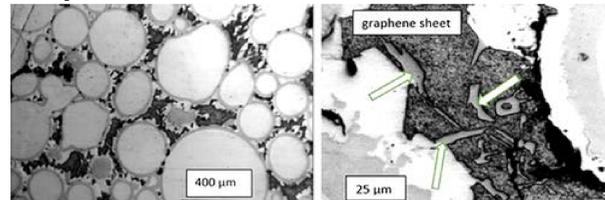


Figure 2: **A** Optical microscopy images of Al composite microstructure. **B** Optical microscopy image at higher magnification to show graphene distribution

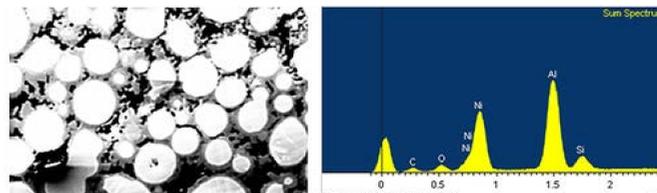


Figure 3: **A** Scanning Electron Microscope (SEM) analysis image of the Al composite. **B** EDX chart showing concentration of elements in matrix with use of fine nickel powder.

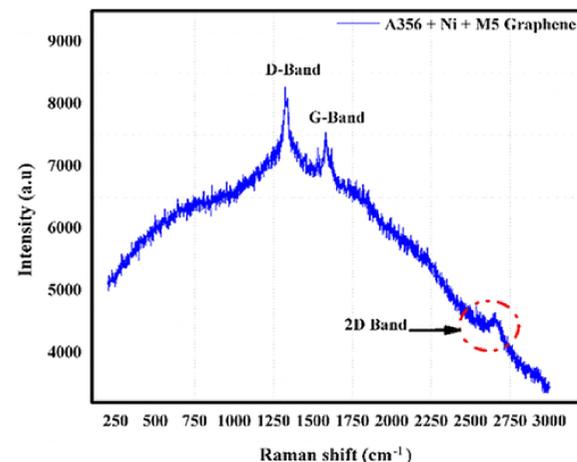


Figure 4: Raman spectroscopy of Al composite sample. The D band circled in red suggest a disordered presence of graphene. Sharp peaks suggest single-layer graphene is present.

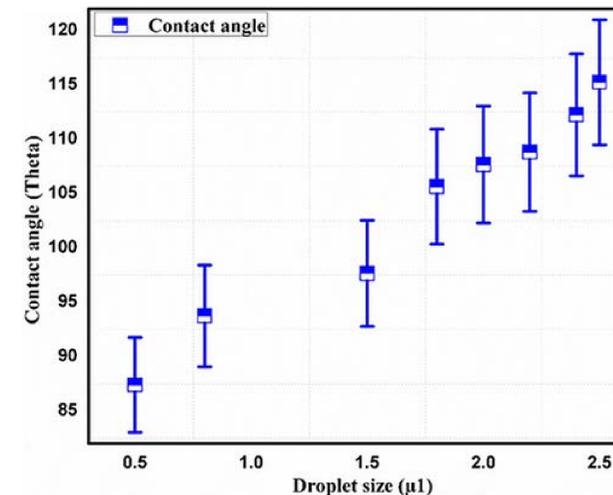
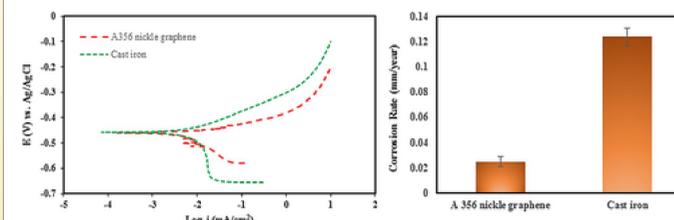


Figure 5: Contact angle and droplet size readings for Al composite.

Wettability

- Phases on the surface and roughness of the surface is used to determine wettability.
- Different droplet sizes were used to determine contact angle of Al composite.



Sample	O.C.P (mV)	E_{corr} (mV)	I_{corr} ($\mu\text{A}/\text{cm}^2$)
A356 nickel-graphene	-0.77	-0.46	2.3
Cast iron	-0.54	-0.44	10.5

- Figure 6: **A** Potentiodynamic polarization. **B** corrosion rate of Al composite vs cast iron. **C** corrosion readings for Al composite and cast iron sample.

Conclusions

- Ni in the matrix aided in the wettability between the graphene and molten Al which resulted in excellent corrosion resistance of the composite.
- Microstructure suggests partly unmelted Ni in the matrix with a coating of Ni-Al and Al-Si with graphene between the Ni.
- Al composite sample was characterized via optical microscopy, SEM, EDX, and Raman spectroscopy.
- Characterization shows graphene present in-between Ni.
- The Al composite sample showed a high contact angle due to the nature of the graphene present which resulted in excellent corrosion resistance of the composite.

Future Work

- Continuation of current experimental process with the substitution of fine nickel powder.
- The purpose of experimenting with nickel powder is to get an even disruption of graphene all throughout the composite.
- Collaborate with local industry

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