Effects of Nanoparticle Size and Aggregation on Metal Nanoparticle-Polymer Thermal Interface Materials

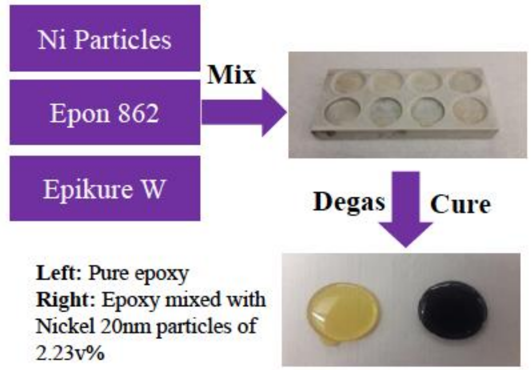
Faculty: X. Ruan Student: Xiangyu Li

Objective

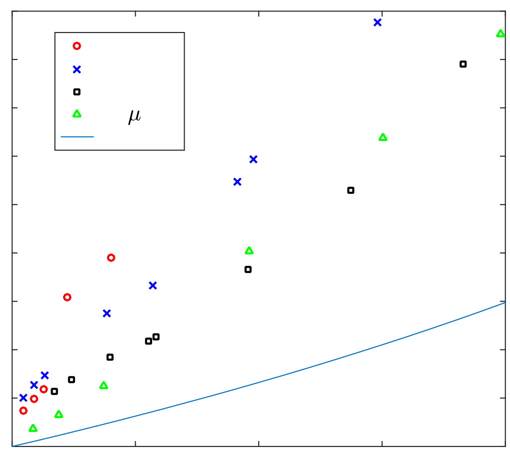
- Fabricate metal-polymer nanocomposite
- Characterize thermal conductivity and aggregation structure
- Develop new EMA model to include particle size, type, concentration, aggregation effect and interfacial resistance

Approach

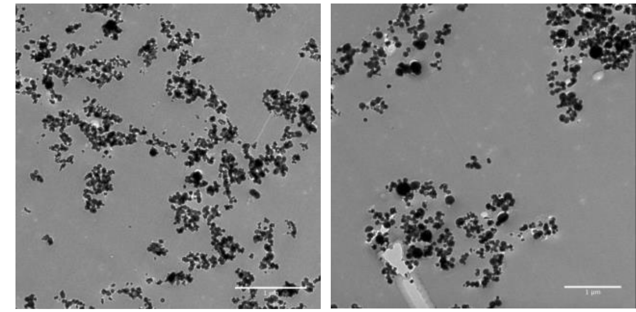
- Nanocomposites are fabricated by directly mixing epoxy and nickel nanoparticles.
- 3ω method is used for thermal conductivity characterization, and TEM for microscopy analysis.
- Aggregation effect is included by 2-level EMA, treating clusters as new particles in matrix.



Fabrication process for nickel-epoxy nanocomposites



Thermal conductivity characterization shows higher value than Maxwell predicts and size-dependent enhancement, where smaller particles yield higher thermal conductivity. Both effects are considered attributed to aggregation effect.



(a) 20nm 5.7v% (b) 70nm 5.5v%

Different aggregation structures are shown in TEM. A more spread-out aggregation structure with smaller particles are more beneficial for thermal transfer.

Impact

- Aggregation effect is responsible for the size-dependent enhancement of thermal conductivity.
- New EMA model is to be developed to consider aggregation effect, to guide and estimate thermal conductivity of nanocomposites.

PURDUE
UNIVERSITY

Cooling Technologies Research Center