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

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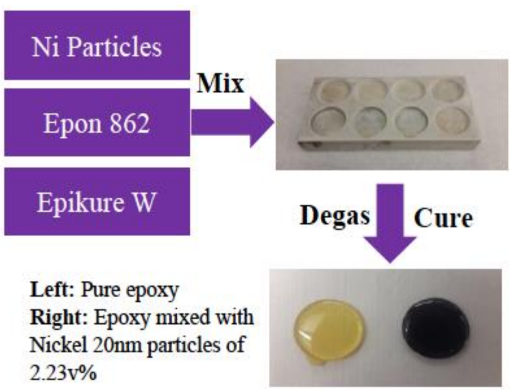
Objective

- 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

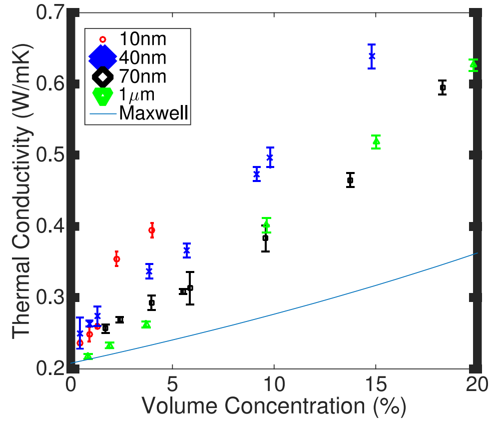
Approach

- Nanocomposites are fabricated with epoxy and nickel particles.



Fabrication process for nickel-epoxy nanocomposites

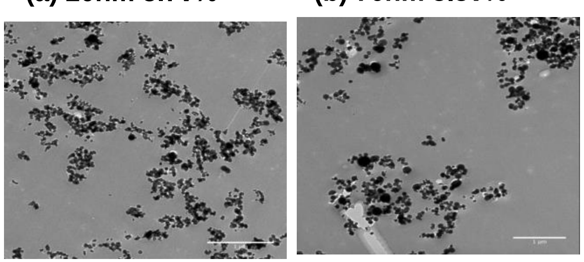
- 3ω method is used for thermal conductivity characterization



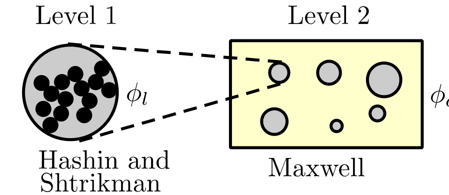
Thermal conductivity characterization shows higher value than Maxwell predicts and size-dependent enhancement, where smaller particles yield higher thermal conductivity. Both effects are considered attributed to aggregation effect.

- Dispersion and aggregation of particles are shown through TEM figures.

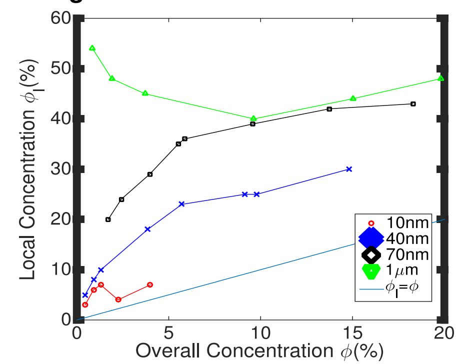
(a) 20nm 5.7v% **(b) 70nm 5.5v%**



A more spread-out aggregation structure with smaller particles are more beneficial for thermal transfer.



2-Level EMA model to explain higher and size-dependent thermal conductivity enhancement by treating aggregation as larger particles. Local concentration, nickel concentration inside clusters is fitted as a parameter, shown in the figure below.



Impact

- Aggregation effect is responsible for the size-dependent enhancement of thermal conductivity.
- 2-level EMA model considers aggregation effect by assuming clusters as new particles.

Li X, *et al*. ASME. *J. Heat Transfer.* 2016;139(2):022401-022401-5.

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