Nanofluid Simulations by Boundary Element Method

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Project Description

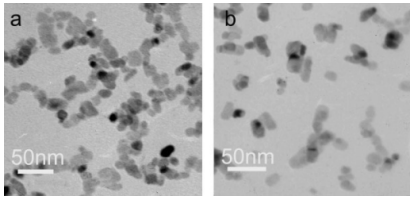
With the advancement of semiconductor device technology, there comes an increasing demand for cooling. Efficient cooling is difficult. Low thermal conductivity of working fluids such as water, oil or ethylene glycol led to the introduction of nanofluids, which represent a novel approach to cooling. Nanofluid is a suspension consisting of uniformly dispersed and suspended nanometer-sized particles in base fluid. Nanofluids have very high thermal conductivities at very low nanoparticle concentrations and exhibit considerable enhancement of convection. Intensive research in the field of nanofluids started only a decade ago. Models for determining effective properties (e.g., viscosity, heat capacity, heat conductivity) have been proposed, which enable relatively easy simulation of nanofluids using existing methods for simulations of pure fluids. We have already implemented this approach in our in-house flow solver. However, recently, models have been proposed that include the actual nanoparticle concentration in determining nanofluid properties. Thus, this project will address nanofluid properties in-situ for each location and at each time separately rather than simplifying the problem by modeling the behavior with fluid with effective properties.

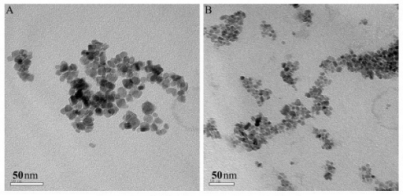
Student Responsibilities

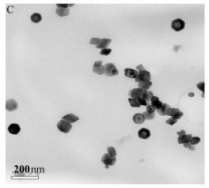
- Learn the principles of boundary element method (BEM) and understand the established algorithm for fluid simulation
- Understand, review and survey the existing literature in nanofluid
- Assist in the development and writing of the nanofluid algorithm

Student Qualifications

- This research is open to students who are in their 3rd or 4th year and have exposure to fluid and thermal sciences
- Good programming skills (Matlab)
- Should be able to commit to the project two or more quarters







H. Zhu et al, TEM images of CuO (Open Access)
B. Zhao and Z Nan, TEM Fe3O4 (Open Access)

Outcomes

Students will be actively involved in leading simulations research in the nanotechnology/nanofluids. This cross-disciplinary (mathematics, engineering, physics, technology, programming) work will provide students with an opportunity to pull learned principles into a nanotechnolgy application that is heavily sought. Students will write peer-reviewed research article for publication. This project is conducted in cooperation with the Faculty of Mechanical Engineering at the Maribor University in Slovenia.

Project Timeframe/Plan

The base BEM project is ongoing. Additional BEM applications will be available for future projects and extensions. Opportunities for paid internships and further studies exist.