

Kostic's Nanofluids Research Activities and Future Plans

More at: www.kostic.niu.edu/DRnanofluids (Argonne's Faculty Research Participation Program in Summer 2004 & 2005)

Future Objectives: Development of hybrid, Drag-Reduction nanofluids and other complex nanofluids with polymer additives (dubbed POLY-nanofluids and DR-nanofluids) and investigation of their structural, diffusion, thermo-physical, flow and heat transfer characteristics, for diverse applications, including: (1) enhanced energy/heat transfer, (2) flow friction reduction and tribology; (3) water treatment and purification; (4) pharmaceuticals and bioengineering; (5) environmental control and cleanup; and (6) development of novel fluid/thermal and environmental/bioengineering sensors, devices and systems. The trend in further development of nano-materials is to make them multifunctional and controllable by external means or by local environment thus essentially turning them into useful nano-devices.

Thermal conductivity studies have been the focus of nanofluid research so far, but ultimately, their flow and heat transfer characteristics in real, practical applications will determine their usefulness as advanced heat-transfer fluids. Many critical phenomena have not yet been investigated, and related underlying physical phenomena are not yet fully understood.

Grants/Funding:

- DOE/RR: Rail-Road Energy Efficiency (Engine & Tribology), 2008-Present
- NSF (Thermal Transport & Thermal Processing) research grant, 2007-2008

Developed/Acquired Apparatus/Equipment:

- Flow and heat Transfer apparatus for nanofluids (n-FHT Apparatus)
- Transient Hot-Wire Thermal Conductivity (HWTC) apparatus for nanofluids
- Steady-state, Parallel-Plate Thermal-Conductivity (PPTC) apparatus for nanofluids
- Cone-and-plate digital viscometer; Analytic digital balance, Ultrasonic mixer
- Malvern Zetasizer Nano-ZS (ZEN3600) for the measurement of size, molecular weight and zeta potential of dispersed particles and molecules in solution

Theses in progress:

- Craig Netemeyer, "Exploring Flow and Heat Transfer Characteristics of New Hybrid Polymer-Nanofluids," M.S. Thesis. Department of Mechanical Engineering, In progress, 2010.

Thesis completed:

- Casey Walleck, "Development of Steady-state, Thermal-Conductivity Apparatus for POLY-Nanofluids and Comparative Measurements with Transient HWTC Apparatus", M.S. Thesis. Department of Mechanical Engineering, Completed in October 2009.
- Kalyan Chaitanya Simham, "Development of Computerized Transient Hot-Wire Thermal Conductivity (HWTC) Apparatus for Nanofluids," M.S. Thesis. Department of Mechanical Engineering, Completed in June 2008.
- Vijay Kumar Sankaramadhi, "Development of Advanced Metal Cutting Nanofluids," M.S. Thesis. Department of Mechanical Engineering, Completed in December 12, 2006

Patents: Kostic *et al.* (Argonne's collaborators), U.S. PATENT APPLICATION for ONE-STEP METHOD FOR THE PRODUCTION OF NANOFLUIDS (DOE/ANL Patent-Appl.No.11/456,944)

Publications:

- Kostic, M and Simham, K.C., *Computerized, Transient Hot-Wire Thermal Conductivity Apparatus for Nanofluids*, Proceedings of the 6th WSEAS International Conference on HEAT and MASS TRANSFER (HMT'09), Ningbo, China, January 10-12, 2009. In RECENT ADVANCES in HEAT and MASS TRANSFER (Editor: Lifeng Xi), ISBN: 978-960-474-039-0; ISSN: 1790-5095, p. 71-78, WSEAS Press. 2009. (**Best HMT09 Conference Paper**)
- Kostic, M., *Effective Thermal Conductivity Errors by Assuming Unidirectional Temperature and Heat Flux Distribution Within Heterogeneous Mixtures (Nanofluids)*, Proceedings of the 5th WSEAS International Conference on HEAT and MASS TRANSFER (HMT'08), Acapulco, Mexico, January 25-27, 2008. In THEORETICAL and EXPERIMENTAL ASPECTS of HEAT and MASS TRANSFER (Editors: J. Krope, S. H. Sohrab, F.-K. Benra), ISBN: 978-960-6766-31-2; ISSN: 1790-2769, p.44-49, WSEAS Press. 2008.
- Kostic, M., "Critical Issues and Application Potentials in Nanofluids Research," ASME-MN2006 Multifunctional Nanocomposites 2006 International Conference Proceedings, September 20-22, 2006, Honolulu, Hawaii, ASME Proceedings, New York, 2006.
- Kostic, M., Vijay Kumar Sankaramadhi, and Kalyan Chaitanya Simham, "New Educational Lab: Measurement And Uncertainty Evaluation Of Nanofluid Particle Concentration Using Volumetric Flask Method," ASEE-2006 IL-IN Section Conference Proceedings, American Society for Engineering Education, Fort Wayne, IN, March 31-April 1, 2006.