Physics Colloquium

Michigan Technological University

Thursday, March 18, 2010, 4:00 pm

Room 139, Fisher Hall

Clustering of Charged Inertial Particles in Turbulence

Jiang Lu

Advisor: Dr. Raymond Shaw

Abstract: Turbulent flows are everywhere. They are known for their efficient mixing, which tends to stretch and deform 'scalar fields' until gradients are sufficiently sharp that molecular diffusion leads to homogenization. Particles with finite inertia, however, form clusters even after mixing in a turbulent flow. If the particles are electrically-charged, the particle dynamics are even more interesting, and we have used digital holography to explore the physics of this process in the laboratory. When particles are identically charged, Coulomb repulsion introduces a length scale below which inertial clustering is negated and the resulting radial distribution function mimics that of a nonideal gas. The result can be described with a Fokker-Planck framework, which models inertial clustering as a diffusion-drift process, modified to include Coulomb interaction. The resulting functional form of the radial distribution function matches our holographic measurements of the clustering of inertial particles closely, thereby providing support for the hypothesized drift-diffusion mechanism of particle clustering.

Properties of Pure and Carbon-decorated Boron Nitride Nanotubes

Chee Huei Lee

Advisor: Dr. Yoke Khin Yap

Abstract: Synthesis of boron nitride nanotubes (BNNTs) is challenging due to the requirement of high growth temperatures and corrosive chemistry. We show that effective growth of high-quality BNNTs can be obtained on Si substrates by a simple thermal chemical vapor deposition technique (Thermal-CVD) without dangerous chemicals. The as-grown tubes are partially vertical aligned, with the typical diameter of 50 nm and length >15 µm, respectively. More importantly, we demonstrate for the first time the patterned growth of long BNNTs at desired locations. This technique could be technologically important for future device applications. BNNT carpets are found to be superhydrophobic with the water contact angle exceeding 150 degree. Since BNNTs are chemically inert and resistive to oxidation up to 1000°C, its superhydrophobic behavior could be potentially useful as self-cleaning, insulating and anticorrosive coating under rigorous chemical and thermal conditions.

While these high-quality BNNTs are having almost constant energy bandgap of ~6 eV, we further show that this bandgap is tunable. By atomic layers coating of carbon on the side wall of BNNTs, the bandgap can be systematically reduced. This on-going project is to produce desirable conductivity in a controllable fashion so as to functionalize BNNTs for device applications.

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