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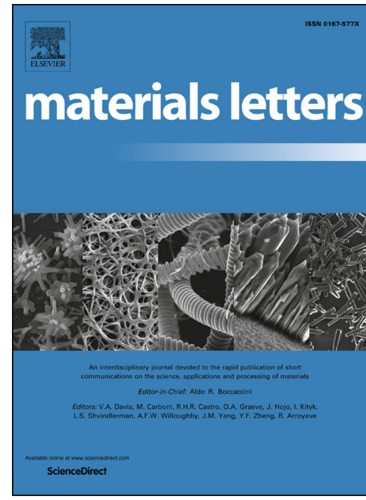

Improving conductivity in carbon nanotube percolating networks through inclusion of Laponite nanoparticles

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Title: Improving conductivity in carbon nanotube percolating networks through inclusion of Laponite nanoparticles

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Abstract:
Obstacles to the commercialization of carbon nanotubes (CNTs) in alternative energy and clean water applications include high production costs, aggregation problems, and poor water solubility. We report the use of Laponite nanoparticles to improve the aqueous phase fabrication of single-walled CNT (SWCNT) percolating networks. SWCNT/Laponite films were cast at varied Laponite and CNT ink concentrations to optimize polydispersity. Structural and morphological characterization identified isolated aggregates, coalesced aggregates, and interconnected networks. Conductive atomic force microscopy studies confirmed that the nanocomposite films maintained their electrical transport properties after heteromixing. Incorporating Laponite improved CNT aqueous dispersibility, prevented aggregation, and promoted continuous, homogenous film formation.

Key words: single-walled carbon nanotubes, Laponite, atomic force microscopy, electronic materials

Introduction:
Carbon nanotubes possess excellent mechanical, electrical, and optical properties [1-3] that have led to their use as sensors, field-effect transistors, batteries, and capacitors [4-7]. Two key hurdles confronting the development of commercial devices are dispersibility and water processability. These nanomaterials have a tendency to aggregate in colloidal aqueous suspensions owing to strong van der Waals forces and high hydrophobicity [8, 9]. Aggregation has been minimized by using surfactants [10], polymers [10-11], functionalization [12-14], and sonication [15]. However, functionalization can lead to degeneration of desired physical properties [16], sonication can truncate nanotubes into smaller lengths which decreases conductivity [15], and removing surfactant ions from the nanotube suspensions can be problematic [17].

Laponite (Lap) is a synthetic clay with chemical formula $Na^{+}_{0.7}$ $[(Si_8\ Mg_{5.5}\ Li_{0.3})O_{20}\ (OH)_4]^{-0.7}$ [9]. Laponite nanoparticles provide versatile inorganic scaffolds with nanoarchitectures that can be selectively tuned to direct interactions across heterointerfaces [18]. Through a simple aqueous phase self-assembly, Laponite films can be coated on different substrates [19-20]. Laponite has been used to improve polydispersity in nanocomposites for light emitting diodes (LEDs), solar cells, and supercapacitor applications [18, 21].