Transparent Electrodes from Nanomaterials for Flexible Devices

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Transparent conductors play an important role in modern electronics. Commercially, this area is dominated by doped metal oxides, most commonly indium tin oxide (ITO). However, the future of ITO as the main material in this area may be limited for economic and technical reasons. In short, a new material is required that must be compatible with low temperature, large area deposition and must be flexible. This is in addition to displaying high transparency, T, and low sheet resistance, Rs. It has been known for the past few years that flexibility and low temperature processing can be achieved by the deposition of nanostructured thin films, often from the liquid phase. These are known to be stable under flexing and can be deposit on flexible substrate. Like carbon nanotubes, graphene can be dispersed in common solvents as well as surfactants and can be deposited as thin film. The most significant materials studied till now are carbon nanotube (CNT), graphene, metal gratings, and random networks of metallic nanowires. CNT and Metal nanowires network have properties that are promising. CNT-PEDOT composites and Graphene-CNT hybrid films are better than CNT only. For most nanostructured films thin enough to display $T >$ 90% (industrial requirement), the conduction can be described by percolation theory. This means DC conductivities are lower than in bulk, giving correspondingly higher sheet resistances, *R*s. To improve our understanding of the consequences of this, we developed a model which relates *T* to *R*s in the percolation regime.

Although main topic of my talk is transparent flexible electrode, last part of my talk will be on liquid phase exfoliation of layered materials. It will cover liquid phase exfoliation of graphene and other inorganic layered materials in solvents and surfactant and their applications.