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Functional metal ions in advanced electronic and luminescent materials

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Metal-ion doped compounds have attracted considerable attention and applied in diverse research fields because of their full spectrum of various behaviors, such as dielectrics, optical spectroscopy and light-emission. TiO₂ co-doped with metal-ions are synthesized and the colossal permittivity (CP) properties of the materials are found based on electron-pinned defect-dipoles mechanism. Structural, optical raman spectra and dielectric properties of the synthesized CP materials are presented. Our results are helpful for not only investigating the new class of CP materials, but also developing dielectric thin film device applications. On the other hand, a large group of luminescent materials or phosphors is so-called metal-ion doped phosphor. In such materials, optical and luminescent characteristics may be controlled by the host and metal-ion dopants (lanthanide or transition metal) of the phosphor. My talk will present the development in the basic design rules of such materials, synthetic approaches, and fabrication processes of metal ion doped phosphors. Metal-ion doped luminescent materials are attracting widespread interest in multifunctional applications. Tuning luminescence of our recent works will be reported on through a variety of techniques, including electric-field, mechanical stress, and magnetic field. Through these works, some potential application can be perceived, which may contribute to future energy devices, sensors as well as self-powered electronics and optoelectronics.

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Synthesis of novel magnetic nanomaterials from functionalized polyolefin oligomers through sustainable chemistry

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Nowadays terminally functionalized polyolefin oligomers can be modified to serve as solubilizing agents to make various polyolefin additives highly soluble in melt phases. Moreover, we have functionalized polyethylene (PE), polypropylene (PP), and Polyisobutylene (PIB) oligomers, converting them into a wide variety of derivatives. For example, antioxidants and photostabilizers are the most prevalent additives for polymers, particularly for polyolefins. Both are important in protecting products during high temperature processing and providing them with longer lifetimes in service under environmentally stressful conditions. These additives could be bound to functionalized oligomers and melted & mixed into the desired materials homogeneously. Magnetic NanoParticles (MNPs) have a versatile scope of applications than carbon nanotubes as they are used in biomedicine, in catalysis, and in materials chemistry. Moreover, MNPs have also been used to form nanocomposites with PE and PP. Polyolefin composites/MNP are currently investigating at Qatar Petrochemical Company (QAPCO at Qatar) with loadings and microscopy studies. Moreover, we have efficiently synthesized PE and PIB oligomer bound dyes, and use these oligomers to design nanoparticles (MNPs) that are soluble in PE and PP melts. These bound species will then be used to modify bulk PE and PP solids or to modify the surface of PE and PP powders or films. These materials will be tested in collaboration with QAPCO's R&D labs and commercialize in future.

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