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Nanoscale Chirality

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Nanoparticles/nanostructures have long been attracting extensive interest thanks to their unique optical and electronic properties that are vastly different from those of their atomic and bulk forms. This material chemistry is further enriched by the recent emergence of nanoscale chirality. Traditionally, chirality refers to the handedness of a molecule or structure that is non-superimposable onto its mirror image, and can be quantitatively assessed by circular dichroism (CD) measurements. This has been observed with a range of molecules, such as peptides, proteins, and DNA, where the CD absorption typically appears in the far ultraviolet region. Recently, a variety of nanoparticles and nanostructures have also been found to exhibit unique chiroptical characteristics in the visible range due to intimate interactions with the nanoparticle surface plasmon resonance (hence denoted as plasmonic circular dichroism, PCD). Such nanoscale chirality has been observed with a chiral core shape, such as helical/spiral structures and/or the formation of chiral staples on the metal core surfaces. In addition, the strong interactions between the surface capping ligands and noble metal nanoparticles, such as gold and silver, can potentially influence the nanoparticle's surface property and give rise to chiroptical response as well. Interestingly, when the interactions between the capping ligands and the plasmonic nanoparticles are relatively weak, the symmetry of the metal core surface will not be changed appreciably upon the formation of a capping layer. In this case, the nanoparticle CD may arise from chiral organic capping ligands that are interacting with the plasmonic nanoparticles, and become intensified with increasing concentration of the chiral molecules on the nanoparticle surface. This is generally ascribed to strong dipole (and higher-order) interactions between the ligand and nanoparticle core electrons. Upon interactions with the chiral ligands, the symmetry of the electronic property of the nanoparticle core surface is distorted, leading to different extinction coefficients between the left- and right-handed circularly polarized light. In addition to individual nanoparticles, nanoparticle assembly with chiral crosslinkers can also exhibit well-defined PCD response (e.g., DNA and peptides). More interestingly, achiral

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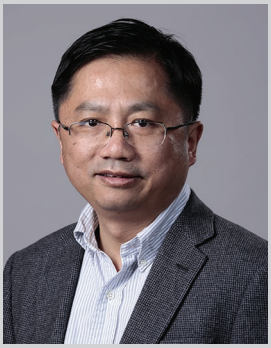

Zhiyong Tang obtained his Bachelor's and Master's degrees from Wuhan University in 1996, and his Ph.D. degree with Professor Erkang Wang in 1999 from Changchun Institute of Applied Chemistry, Chinese Academy of Sciences. After six years as a postdoctoral fellow in Swiss Federal Institute of Technology Zurich, Oklahoma State University and University of Michigan, he joined the National Center for Nanoscience and Technology, China, in November 2006 as part of the 100-Talent Program of the Chinese Academy of Sciences, and has been a professor ever since. His research interests are mainly focused on controllable synthesis, property manipulation and practical applications of inorganic nanomaterials.

nanoparticles can assemble into chiral nanostructures and produce apparent chiroptical response, even without the use of chiral crosslinkers. As the resulting PCD is sensitive to the chemical nature and surface morphology of nanoparticles and the specific arrangement of nanoparticles in the ensemble structures, it can be exploited as a unique platform for diverse applications such as chiral sensing and catalysis. Indeed, in recent years, there has been rapid progress in the research of nanoscale chirality both from the experimental and theoretical perspectives. Some of these breakthroughs are highlighted in this special issue.

We are grateful to the various leading experts in the field for their contributions to this collection, and excited to share with you the latest advances of nanoscale chirality. We look forward to an even brighter future of the field.

Happy reading.....

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