Nanotechnology and nanomaterials

Exploring Electrical and Dielectric Properties in Ionic Liquid Crystals Tuned by Nanoparticles

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Nanoparticles in combination with liquid crystals facilitate the design of nanocomposite materials with unique photoelectric or nonlinear optical characteristics. This makes such materials multifunctional and adjustable for a wide range of applications, including sensors to optical devices.

A promising matrix for the development of nanocomposite materials is the thermotropic ionic smectic A $Cd^{+2}(C_7H_{15}COO^-)_2$ (CdC_8) liquid crystal. This liquid crystals can perform nanoreactor functions for synthesizing different types of nanoparticles: semiconductor, metal, metal alloys and hybrid (core/shell). The shape and size of nanoparticles in our synthesized composite materials are measured using scanning electron microscopy and transmission electron microscopy. These methods allow us to obtain high-resolution images and precisely study the distribution and characteristic sizes of the nanoparticles in the CdC_8 matrix. The samples are measured using impedance spectroscopy in a wide range of frequencies and temperatures. The dielectric properties of composite materials based on CdC_8 matrix with semiconductor and metallic nanoparticles are analyzed using 2 visualizing methods (Nyquist and Bode plots). This allows us to analyze separately the different components and processes that occur in the system: polarization effects, electrode contact resistances, liquid crystal volumes and others to evaluate their contributions to the general behavior of the material. Using impedance spectroscopy method, we evaluated the material characteristics including ion mobility and rates of relaxation processes. The results provide a fundamental understanding of the behavior of nanocomposite materials and have a great potential for the development of sensors and optical devices.

D. Z. greatly appreciates a research grant from the German National Academy of Sciences Leopoldina. V.C. is very grateful for the DAAD grant.