

Nanocomposites and nanomaterials

Size Effects in the Thermochromic Single Crystals and Nanocomposites

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The thermochromic phase transitions were observed in some organic-inorganic crystalline compounds of A_2CuCl_4 and $ACuCl_3$ family, where A is an alkylammonium cation.

The crystals of diethylammonium tetrachlorocuprate $[NH_2(C_2H_5)_2]_2CuCl_4$ (DEACC) at $T_T = 307.5$ K (on cooling) undergo a first order thermochromic phase transition connected with the change of the copper ion coordination which is followed by the change of the sample's colour from light yellow to deep green. Unfortunately, the practical application of this property is restricted by high hygroscopicity of DEACC crystals. It was supposed, that incorporation of the nanocrystals (NC) of the mentioned substances into a polymer matrix could resolve this problem. Besides using such an approach one can obtain the possibility to observe the manifestations of size effects and related phenomena in the absorption spectra of crystalline ferroics with an alkylammonium cation.

The optical and spectral properties of DEACC NC incorporated into the polymer matrices were investigated and specific manifestation of thermochromic properties and size effects were revealed. It was found that comparatively large nanocrystals with the sizes of about 160 nm undergo the thermochromic phase transition but at lower temperature ($T_T = 298$ K on cooling). It appears as the considerable step-like change of the absorption in the region of the charge transfer bands. On the other hand, it was revealed that for the considerably smaller nanocrystals (threshold diameter <10 nm) the lateral tensions arising on their surface suppress the octahedral coordination of the copper ion characteristic of the low temperature phase of the bulk crystal and the thermochromic phase transition is not observed anymore.