Polaron transport in nanocrystal solids

Nikola Prodanović[1], Nenad Vukmirović[1]
[1]*Scientific Computing Laboratory, Institute of Physics Belgrade, Serbia*
email: prodanovic@ipb.ac.rs

Colloidal quantum dot supercrystals are novel nanostructured materials which appear very promising in potential optoelectronic applications and for fundamental study of electronic transport properties in condensed matter physics. Recent fabrication of high quality supercrystals with relatively strong inter-site electronic coupling and high size monodispersity enabled high carrier mobilities that slightly increase with decreasing temperature. Due to such temperature behaviour it is believed that such transport is so called coherent band-like transport.

We developed an accurate model accounting for electron-phonon interaction in colloidal quantum dot supercrystals that allowed us to identify the nature of charge carriers and the electrical transport regime. We find that in experimentally relevant CdSe nanocrystal solids the electron-phonon interaction is sufficiently strong that small polarons localized to single dots are formed. Charge-carrier transport occurs by small polaron hopping between the dots with mobility that decreases with increasing the temperature. While such a temperature dependence of mobility is usually considered as a proof of band transport, we show that the same type of dependence occurs in the system where transport occurs by small polaron hopping.

REFERENCES

[1] N. Prodanović, N. Vukmirović, Z. Ikonić, P. Harrison, and D. Indjin, J. Phys. Chem. Lett. 5, 1335 (2014).