Thermoelectric Nanocrystal Ensembles: Synthesis, Assembly and Transport Properties

Marek Piotrowski, Yury V. Kolen'ko

International Iberian Nanotechnology Laboratory, Braga, Portugal

Alongside alternative clean energy sources, energy recovery and conversion will play an important role in addressing future technologies, especially for autonomous devices. Thermoelectric (TE) devices that convert temperature gradients into electric power and *vice versa* have been actively investigated with the aim of enhancing existing technologies for heat/power recovery and conversion. They are reliable, non-polluting, require minimal maintenance, and can be operated over a wide range of temperatures [1].

Owing to intrinsic difficulties in decoupling electrons and phonons in bulk solids, the efficiency of bulk TEs continues to be low. When integrated into a real device, the best bulk TE materials have the figure of merit, zT, around 1.2, but an average zT = 3-4 is necessary to make a significant impact in TE energy conversion. Nanocrystal (NC) superlatices are very interesting as they exhibit complex property correlations, and can be a benchmark for the discovery of novel TE materials with extraordinary responses. Specifically, while strongly coupled in conventional materials, in the NC superlatices, electron and phonon scattering can be decoupled by combining intrinsic NC properties, proximal interactions, and nanostructuring.

We have shown that highly monodisperse NCs can be successfully synthesized on the large scale. Self-organization of the NCs leads to the formation of the structures where NC packaging is primarily determined by the concentration of the NCs in the suspension and the deposition method. Next, we fabricated thermoelectric NC ensembles on flat substrate (Fig. 1a) as well as on substrate with predefined cavities (Fig. 1b). The resultant NC enessemblies were subjected to ligand exchange/anealing in order to enable strong coupling interactions in the NC ensembles. Transport properties of the resultant TE NC arrays will be discussed.

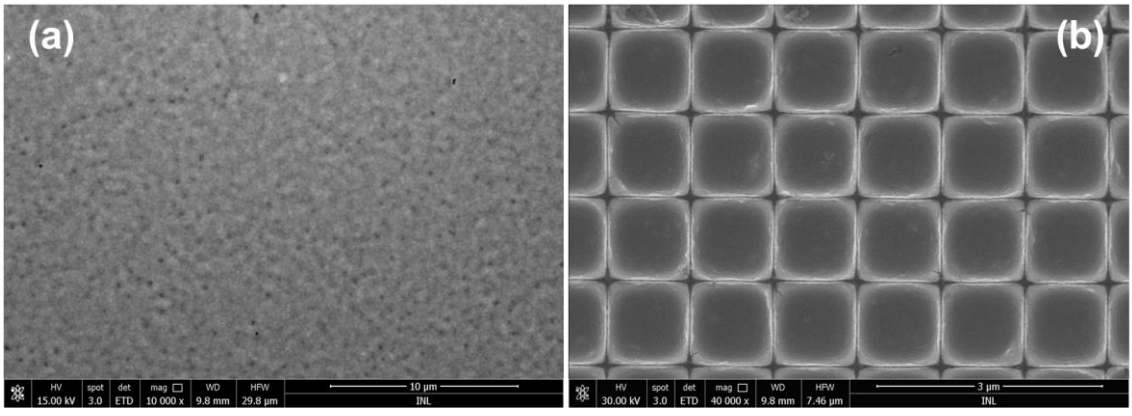

Fig. 1 SEM images of the assembly of PbTe NCs on flat (a) and prepatterned (b) Si substrates.

1) L. E. Bell, *Science*, **2008**, *321*, 1457.