Innovative Methods for Production of High Volume Fraction Quantum Dots: Applied for Enhanced Thermoelectric Properties (with ZT > 3.0)

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For the past thirty years the ion beam users have successfully produced nanocrystals of various elements in all variety of substrate. Also, a large number of workers have tried to control the size, distribution, and volume fraction of such nanocrystals on the surface and inside substrate by ion beam. As of today, only two groups, Hubler et al [1] and ILA et al [2] have reached such high volume fraction of nanocrystals in order to infer the creation of pseudo-quantum dot lattices which have been shown in a series of research works initiated during the past decade. The researchers have theoretically shown the enhancement of the thermoelectric figure-of-merit in regimented quantum dot super lattices [3, 4]. For this presentation we have selected simple systems of metal such as gold, silver and/or copper in silica (SiO_2) and techniques such as Ion Beam Assisted Deposition (IBAD), using argon beam, and post bombardment by 5 MeV Si beam. In this work, we use the term quantum dots for quantum confined nanocrystals as small of at about 1 nm diameter. Using these two methods we produced highly efficient conformal thermoelectric materials, figure 1, which can operate at room temperatures and at temperatures as high as 973K [2, 5].

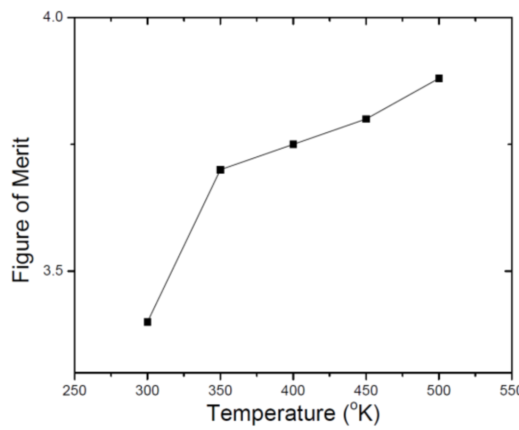

Fig. 1 Measured Figure of Merit vs. Temperature

During this lecture we will review the results from past decades and present our most recent finding which resulted in production of thermally high insulating but electrically high conductive materials with high Seebeck coefficients produced by IBAD and produced by post bombardment by MeV ion beam.

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