Metacrystals: opportunities and issues for future quantum devices

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In last few decades, challenges arose to come up with useful multilayer semiconductor structures in microelectronics. The fabrication methods that have worked in the past may have a limited lifetime in the near future. New nanoscale fabrication methods can provide opportunities to create devices with unprecedented versatility. Presently, quantum dot (QD) studies are focused on size uniformity and array formation. Studies of QD interactions have indicated that band formation is a possibility with close lateral spacing and vertical stacking of dots. Versatile functionality will result from novel combinations of quantum dots and sublattice materials, limited by fabrication technology and compatibility. The computational challenges will be to determine the energy levels in variously shaped quantum dots with varying degrees of defects, predict the band gap for QD superlattices, and static and dynamic perturbation effects of strain, electric and magnetic fields, and nonlinear optics imposed by the sublattice/quantum dot combination. Early investigations into the potential enabled by new combinations of nanoscale materials can drive the development of new fabrication methods.