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Pressure-Directed Assembly: Nanostructures Made Easy

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Precise control of structural parameters through nanoscale engineering to improve optical and electronic properties of functional nanomaterials continuously remains an outstanding challenge. Previous work has been conducted largely at ambient pressure and relies on specific chemical or physical interactions such as van der Waals interactions, dipole-dipole interactions, chemical reactions, ligand-receptor interactions, etc. In this presentation, I will introduce a new pressure-directed assembly method that uses mechanical compressive force applied to nanoparticle arrays to induce structural phase transition and to consolidate new nanomaterials with precisely controlled structures and tunable properties. By manipulating nanoparticle coupling through external pressure, instead of through chemistry, a reversible change in their assemblies and properties can be achieved and demonstrated. In addition, over a certain threshold, the external pressure will force these nanoparticles into contact, thereby allowing the formation and consolidation of one- to three-dimensional nanostructures. Through pressure induced nanoparticle assembly, materials engineering and synthesis become remarkably flexible without relying on traditional crystallization process where atoms/ions are locked in a specific crystal structure. Therefore, morphology or architecture can be readily tuned to produce desirable properties for practical applications. Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.