# INORGANIC NANOPARTICLES AS PHASE-CHANGE MATERIALS FOR LARGE-SCALE THERMAL ENERGY STORAGE

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Solar thermal collectors are able to utilize the entire spectrum of incident radiation, including the IR range, and high-temperature conversion of heat to electricity is highly efficient. The capability for continuous, rather than cyclic, power generation at high efficiency could revolutionize the development of solar energy. Nanoparticle-based phase-change materials (PCMs) have the potential for superior reversibility of phase transitions; suspensions of particles have advantages in remaining fluid in a wide temperature range below and above the phase transition temperature. The goal of this project is to expand the fundamental understanding of solid-state phase changes and solid-fluid interactions in inorganic nanoparticle dispersions as the foundation for novel high-temperature thermal storage media. Stable inorganic nanoparticles featuring high-enthalpy solid-solid phase transitions, such as metal oxides with structures stabilized by optimized carrier solutions, may be significantly more robust than organic materials, enabling multiple reversible charge/discharge cycles at high temperature. Suspensions of zirconium and titanium oxide nanoparticles were chosen as the prototype candidates for investigation of phase transitions between polymorphic structures in aqueous environment. Crossovers of the transition enthalpy in function of particle size were found previously in these and many other polymorphic systems. The project includes particle synthesis and characterization, calorimetric determination of phase transitions at temperatures to 400 °C, and MD simulations of the interactions at the particle-solution interface. Theoretical predictions and experimental verification of the equilibrium and kinetic properties of nano-PCMs will establish the fundamental basis for predicting thermal storage performance. The expected immediate outcome of this effort is the demonstration of high-energy solid-solid transitions in stable nanoparticles that can lead to development of new high-temperature PCMs.

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