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Article

Solid-State Reactions for the Storage of Thermal Energy

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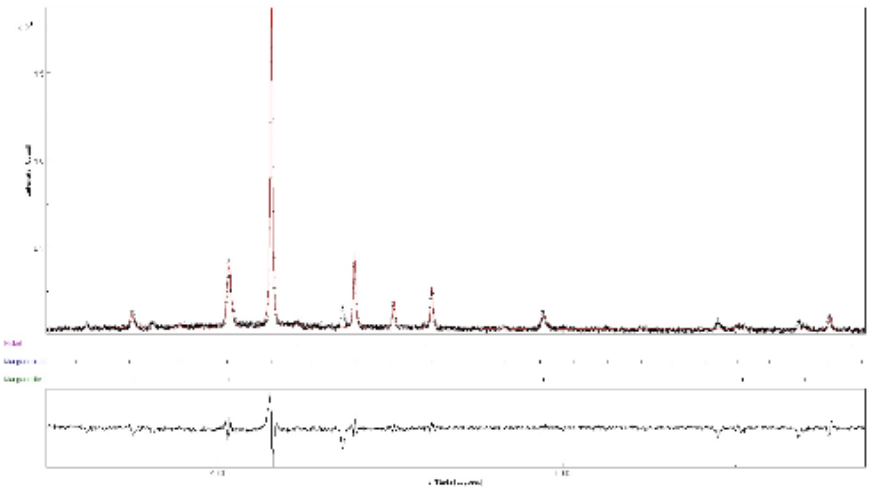
Abstract

In this paper, the use of solid-state reactions for the storing of thermal energy at high temperature is proposed. The candidate reactions are eutectoid- and peritectoid-type transitions where all the components (reactants and reaction products) are in the solid state. To the best of our knowledge, these classes of reactions have not been considered so far for application in thermal energy storage. This study includes the theoretical investigation, based on the Calphad method, of binary metals and salts systems that allowed to determine the thermodynamic properties of interest such as the enthalpy, the free energy, the temperature of transition, the volume expansion and the heat capacity, giving guidelines for the selection of the most promising materials in view of their use for thermal energy storage applications. The theoretical investigation carried out allowed the selection of several promising candidates, in a wide range of temperatures (300–800 °C). Moreover, the preliminary experimental study and results of the binary Mn-Ni metallic system are reported. This system showed a complex reacting behavior with several discrepancies between the theoretical phase diagram and the experimental results regarding the type of reaction, the transition temperatures and enthalpies and the final products. The discrepancies observed could be due both to the synthesis method applied and to the high sensitivity of the material leading to partial or total oxidation upon heating even if in presence of small amount of oxygen (at the ppm level). View Full-Text

Keywords: solid state reactions; thermal energy storage; nanocrystalline materials; ball milling

▼ Figures



Graphical abstract