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Comparative Analysis of Co-precipitation and Sol-Gel Derived $Sm_2Ni_2O_5$ Nanoparticles: Structural, Chemical, Thermodynamic, and Magnetic Properties

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In this study, crystalline $Sm_2Ni_2O_5$ nanoparticles (SNONPs) were synthesized using both the co-precipitation and sol-gel methods to compare the influence of the synthesis' method on the structural, chemical, thermodynamic, and magnetic properties of the material. X-ray diffraction (XRD) analysis revealed that samples from both methods crystallized in an orthorhombic structure of the Ima2 space group after annealing at 800 ℃. SEM images revealed that co-precipitated samples had spherical particles, while sol-gel samples exhibited irregular, textured morphologies. EDS results showed comparable elemental compositions in both samples, with slight variations in oxygen content. Specific heat (Cp) measurements under a 0.5 T magnetic field revealed a ferromagnetic transition at ~42.3 K in both cases. Additionally, a sharp increase in Cp below 150 K and a deviation in Cp/T below 9 K suggested the onset of spin ordering due to magnetic interactions between Sm^{3+} (4f) and the mixed oxidation states of Ni (Ni^{2+} and Ni^{3+}). These findings highlight the impact of synthesis route on the crystallinity and consequently the chemical, thermodynamic and magnetic behavior of SNONPs, suggesting its potential for spintronic and low-temperature magnetic applications.

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