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Structural Properties of Nanocrystalline Olivine Prepared by Ball Milling

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One goal of modern materials research and development has been to identify simpler processing schemes that do not require high-temperature treatment to induce solid-state reactions. Among the many types of preparation techniques, the nonconventional mechanochemical synthesis has been recognized as a powerful route to novel, high-performance and low-cost nanomaterials [1].

In the present work, a synthesis of nanocrystalline olivine $(\text{Fe}_x\text{Mg}_{1-x})_2\text{SiO}_4$ ($x = 0, 0.5, 1$) prepared via mechanochemical processing of the $\alpha\text{-Fe}_2\text{O}_3/\text{Fe}/\text{MgO}/\text{SiO}_2$ mixture in argon atmosphere at room temperature is reported. The mechanically induced phase evolution of the mixture is followed by XRD. Due to the ability of ^{57}Fe Mössbauer spectroscopy to discriminate between probe nuclei on the two nonequivalent crystallographic sites provided by the olivine structure (octahedrally coordinated M1 and M2 sites), valuable insight into the local cation disorder in mechanosynthesized $(\text{Fe}_x\text{Mg}_{1-x})_2\text{SiO}_4$ is obtained. However, it was found that Fe^{2+} has a slight preference for the M1 site at temperatures below approximately 500 °C, with a tendency of disordering around this temperature [2,3], the cation distribution in nanosized materials is still not clear. Quantitative information on the short-range structure, provided by the nuclear spectroscopic technique, is complemented by the investigation of the magnetic behavior (SQUID measurements) of mechanochemically prepared olivine on a macroscopic scale. High-resolution TEM studies revealed a non-uniform structure of mechano-

synthesized $(\text{Fe}_x\text{Mg}_{1-x})_2\text{SiO}_4$ nanoparticles consisting of an ordered core surrounded by a disordered surface shell region.

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