THESIS DEFENSE

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Phase Stability, Sintering, and Electrical Properties of the (Mg,Ni,Co,Cu,Zn)O Entropy Stabilized Oxide System

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Abstract: This thesis focuses on the synthesis and characterization of the recently discovered (Mg,Ni,Cu,Co,Zn)O entropy stabilized oxide. In this system, oxygen populates the anion sublattice of the FCC rock-salt structure, while the five cations randomly populate the cation sublattice. The configurational entropy within this system is maximized with equimolar amounts of the five cations, where it overcomes the enthalpy of mixing of the components and stabilizes the single-phase solid solution.

Various techniques are employed to characterize the formation mechanisms of the single-phase and its stability under different temperatures. Upon heating at temperatures below 875 °C, a copper-rich tenorite precipitate forms, providing another method for controlling the microstructure. The reversibility of the formation of the single-phase solution is paramount to the entropy stabilization.

Octahedrally coordinated Cu^{2+} ions undergo Jahn-Teller distortion and have been shown to cluster within the rock-salt lattice to relieve the stress induced by these distorted bonds. While the global structure of this single entropy stabilized phase is rock-salt, under certain processing conditions, selective peak broadening appears which suggests the presence lattice distortion. This is hypothesized to be the result of copper-rich nanoscale defects where the cations are displaced from ideal lattice sites, due to the tetragonal distortion around these ions.

Samples were sintered to >95% density using mixed oxide processing and solid-state sintering, which is an improvement on previous attempts to densify this material by these methods. Dilatometry revealed two distinct temperature regimes where densification occurs at different rates, indicating the presence of different active sintering mechanisms.

DC and AC measurements were employed to characterize the electrical properties of 95% dense samples. The single-phase entropy stabilized oxide is insulating at room temperature with resistivity values on the order of 10^9 Ω m and possesses several thermally activated conduction mechanisms. When heat treated at lower temperatures to precipitate tenorite, the electrical resistivity drops by 6 orders of magnitude.

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