

**SPINELS RENAISSANCE—PAST, PRESENT, AND FUTURE**

**Synthesis of stoichiometric nickel aluminate spinel nanoparticles†**

**MD. HASAN<sup>1</sup>, JOHN DRAZIN<sup>1</sup>, SANCHITA DEY<sup>1</sup> AND RICARDO H.R. CASTRO<sup>1,\*</sup>**

<sup>1</sup>Department of Chemical Engineering and Materials Science, University of California-Davis, One Shields Avenue, Davis, California 95616, U.S.A.

**ABSTRACT**

Nickel aluminate is a transition metal oxide with spinel structure with potential applications as catalysts and sensors. Both applications benefit from high specific surface areas as well as chemical stoichiometry control. However, a systematic approach to understand synthetic parameters affecting stoichiometry and agglomeration of nickel aluminate nanoparticles is still lacking. In this work, co-precipitation using direct and reverse strikes and polymeric precursor techniques were comparatively studied to address this problem. While the polymeric method could deliver stoichiometric spinel, the samples were highly agglomerated exhibiting low surface area. Both co-precipitation procedures produced smaller sizes and less agglomerated nanoparticles as compared to the polymeric precursor, but for the reverse-strike, Ni<sup>2+</sup> preferentially formed a soluble complex with ammonia and led to nickel deficient nanoparticles. Stoichiometric (1 mol NiO:1 mol Al<sub>2</sub>O<sub>3</sub>) nanocrystalline nickel aluminate was only achieved when using controlled excess Ni<sup>2+</sup>. The normal-strike lead to more stoichiometric compositions without need for excess cations, but the obtained nanoparticles were less homogeneous and showed smaller surface areas as compared to the reverse-strike method.

**Keywords:** Spinel, nickel aluminate, nanopowder, stoichiometry