

# Synthesis and Characterization of Highly Ordered Mesoporous Transition Metal Oxide with Spinel Framework Structures

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Composite materials containing two or more types of cations with spinel structure are of intense interests in material research because of their remarkable optical, electrical, and magnetic catalytic properties in science and engineering. Among these, spinel materials ( $AB_2O_4$ ; A = Mn, Co, Ni, and Zn, B = Mn, Fe, Co) have recently drawn a considerable attention by virtue of their superior physicochemical properties and tremendous potential for many technological applications, such as catalysis, sensors, and electrochromic devices

In this study highly ordered mesoporous  $AB_2O_4$  (A = Mn, Co, Ni, and Zn, B = Mn, Fe, Co) spinel materials have been synthesized by nano-casting, using KIT-6 silica as a hard template.

Low-angle X-ray diffraction (XRD) patterns of highly ordered mesoporous of  $AB_2O_4$  (A = Mn, Co, Ni, and Zn, B = Mn, Fe, Co) spinel materials are quite different from KIT-6 silica template. A new (110) peak appears before  $2\theta = 1^\circ$ , which indicates the meso-structure transformation from cubic to tetragonal or the lower space group after the silica template etching process.

In wide angle XRD pattern, synthesized highly ordered mesoporous spinel are matched with  $Mn_3O_4$  (JCPDS 24-0734),  $NiMn_2O_4$  (JCPDS 1-1110)  $ZnMn_2O_4$  (JCPDS 24-1133),  $CoFe_2O_4$  (JCPDS 22-1086),  $NiFe_2O_4$  (JCPDS 74-2081),  $ZnFe_2O_4$  (JCPDS 89-4926),  $MnCo_2O_4$  (JCPDS 23-1237),  $Co_3O_4$  (JCPDS 42-1467),  $NiCo_2O_4$  (JCPDS 73-1702), and  $ZnCo_2O_4$  (JCPDS 23-1390).

$N_2$  adsorption-desorption isotherms show that the obtained replicas possess high specific surface areas ( $92\text{--}125\text{ m}^2\text{ g}^{-1}$ ), and large pore volumes ( $0.11\text{--}0.26\text{ cm}^3\text{ g}^{-1}$ ).

The SEM images prove their mesoporous structures, indicating that nano-replication were successfully performed very uniformly without formation of other metal oxide phase.

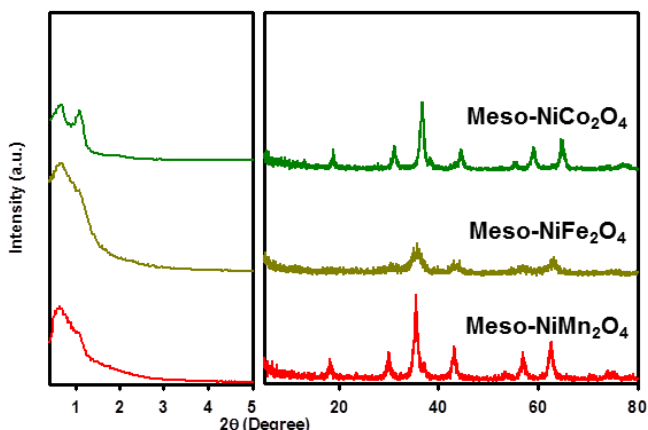


Fig.1. XRD patterns of meso- $NiCo_2O_4$ ,  $NiFe_2O_4$  and  $NiMn_2O_4$ .

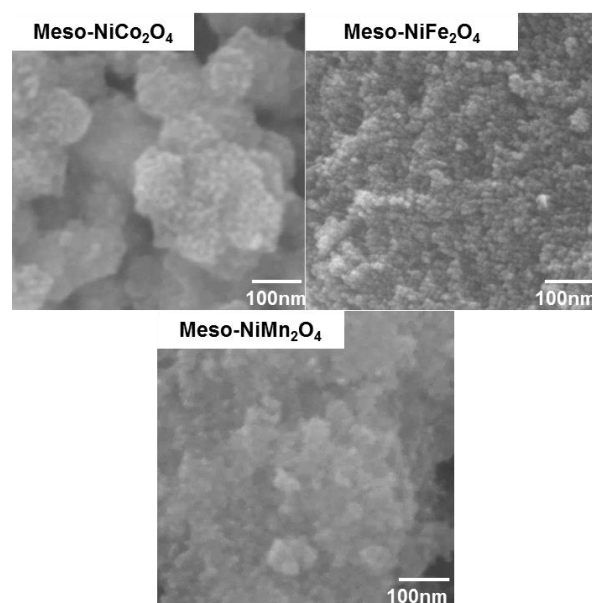


Fig.2. SEM images of meso- $NiCo_2O_4$ ,  $NiFe_2O_4$  and  $NiMn_2O_4$ .

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