**Exploration of structural, optical, and magnetic properties of Al3+ - doped Ni-Zn-Co nano-spinel ferrites**

Nusrat Jahana,b\*, Jahirul I. Khandakera , and Md Nazrul I. Khanc

a Department of Physics, Jahangirnagar University, Savar, Dhaka 1342, Bangladesh

b Department of Physics, American International University Bangladesh (AIUB), Dhaka 1229, Bangladesh

c Materials Science Division, Atomic Energy Centre, Dhaka 1000, Bangladesh

This study explored the structural, morphological, optical, and magnetic properties of Ni0.4Zn0.35Co0.25Fe2-xAlxO4 (*0 ≤ x ≤ 0.12*) nano-spinel ferrites. Thermogravimetric analysis and differential scanning calorimetry (*TGA - DSC*) determined nanocrystalline cubic structure formation. Single-phase cubic spinel structures with *Fd3m* space group of synthesized samples confirmed by Rietveld refinement X-ray diffraction (*XRD*) data. The particle sizes ranged from 6.7 nm - 5.25 nm, and agglomeration occurred inside the ferrite samples. The atomic planes and strong crystallinity were detected through selected area electron diffraction (*SAED*) images. The existence of metal-oxygen (*M-O*) bonding was identified by the Raman spectra' characteristic peaks inside the sub-lattices. The optical bandgaps (*Eg*) were found 2.1 eV – 2.52 eV for all the samples. Superparamagnetic natures of the nano samples were conformed through the *S* - shape hysteresis (*M - H*) loops. The studies' outcomes indicated the applicability for biomedical applications of these nano samples.