## IJARSCT



International Journal of Advanced Research in Science, Communication and Technology

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

Volume 5, Issue 8, April 2025



## Structural and Optical Study of Lead Doping on Cobalt Ferrite Nanoparticles Synthesized via Sol-Gel Autocombution Method

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**Abstract:** Lead  $(Pb^{2^+})$  substituted cobalt ferrite  $(Co_1 - _xPb_xFe_2 O_4, x = 0.1-0.5)$  nanoparticles were synthesized via the sol-gel autocombustion method to investigate the impact of  $Pb^{2^+}$  concentration on structural and optical properties. X-ray diffraction (XRD) confirmed phase purity, with an increasing lattice parameter due to the larger ionic radius of  $Pb^{2^+}$ . UV-Visible spectroscopy revealed an absorption edge shift (690–703 nm), and band gap values were determined using both absorption edge and Tauc's plot methods. The band gap decreased up to x = 0.3 due to impurity band formation and grain size effects but increased at x > 0.3, attributed to the Burstein–Moss effect. The findings highlight the tunability of  $CoFe \square O \square$  properties through  $Pb^{2^+}$  substitution, making them promising for optoelectronic applications.

Keywords: Nanoparticles, Cobalt Ferrite, Sol-Gel Method, Optical Properties





