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# Superparamagnetic behaviour and evidence of weakening in super-exchange interactions with the substitution of $Gd^{3+}$ ions in the Mg-Mn nanoferrite matrix

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Graphical abstract

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SEM image for $Mg_{0.9}Mn_{0.1}Gd_{0.2}Fe_{1.8}O_4$ nanoferrite

## HIGHLIGHTS

1. $Gd^{3+}$ substituted Mg-Mn nanoferrites have been synthesized for the first time by solution combustion technique.
2. Superparamagnetism has been observed due to the small particle size in the nano range.
3. A detailed structural analysis has been presented.
4. Super-exchange interactions have been explored theoretically as well as experimentally.

## ABSTRACT

The $Gd^{3+}$ substituted Mg-Mn nanoferrites with generic formula $Mg_{0.9}Mn_{0.1}Gd_xFe_{2-x}O_4$ (x = 0.05, 0.1, 0.2, 0.3) have been prepared for the first time by self-ignited solution combustion method. The X-ray analysis confirmed the formation of single phase cubic spinel structure. $Gd^{3+}$ substitution has resulted in an increase in the crystallite size (13.4-16.1 nm) and lattice