Mn^{2+} Luminescence in ZnS Under High Pressure

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Manganese (Mn^{2+}) doped Zinc sulfide(ZnS) sample has potential applications in detectors, display devices and biological fields [1, 2]. In this work, a comprehensive pressure and temperature-dependent luminescence analysis of ZnS:Mn^{2+} nano phosphor with a zinc blende structure is conducted. The nano phosphor was characterized utilizing XRD, SEM, ambient, low temperature and high-pressure luminescence measurements and decay analysis. The high-pressure studies were done at ambient temperature using a diamond anvil cell (DAC) with a pressure-transmitting medium of methanol-ethanol mixture.

The sample was synthesized by a simple chemical precipitation method containing quantum dot-sized nanocrystallites with excellent orange luminescence related to the $^4T_1$-$^6A_1$ transition at ambient conditions. The sample also exhibits stable and identical luminescence behaviour under different types of excitations like UV and X-ray at ambient conditions. The impact-induced mechanoluminescence features of the sample were also investigated and compared with a wurtzite ZnS sample.

The pressure and temperature-induced luminescence mechanism of the phosphor is established via the d^5 Tanabe Sugano diagram. The Mn^{2+} luminescence band shifts with both pressure and temperature and the broad luminescence band of the $^4T_1$-$^6A_1$ transition shifts from the visible to near-infrared range at a rate of - 35.8 meV/GPa with the increase of the pressure. The luminescence subsequently quenched completely at 16.41 GPa due to a pressure induced reversible phase transition from zinc blende ($F\bar{4}3m$) to rocksalt ($Fm\bar{3}m$) structure. The decay kinetics measurements of the sample luminescence with respect to pressure and temperature also established.

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