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Synthesis, characterization and magnetic ordering of the semiconducting intermetallic compound FeGa_3

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Abstract :

Intermetallic compounds which are formed by good conductive metals are usually metallic. However, FeGa_3 was found to be a semiconductor with a narrow gap measured to be between 0.2 and 0.46 eV [1,2,3]. This gap mainly arises from the hybridization between the Ga 4p and Fe 3d bands [4]. The band-gap has been established experimentally by various techniques [4,5], and its origin verified by density functional theory (DFT) calculations [2,5]. FeGa_3 crystallizes in the tetragonal space group $P4_2/mnm$ (No. 136) [3]. The magnetism in this compound has not yet been observed, with various magnetization and specific heat measurements suggesting that it does not occur down to very low temperatures [4,6]. Recent work has also shown that the effect of the chemical doping on single crystal FeGa_3 creates a spin 1/2 local moment and drives the compound to become metallic [7]. Mössbauer spectroscopy (MES) has shown the absence of an internal magnetic field at the site of Fe confirming that no ordering above room temperature occurs [3]. FeGa_3 has recently been predicted to become metallic under pressure [1]. We will report on the preliminary results for this project. In particular, we will show how FeGa_3 single crystals has been synthesized by the self flux method, and then characterized by means of x-ray diffraction, energy dispersive analysis and MES. Furthermore, our measurements of the magnetic state of FeGa_3 as a function of temperature using MES will provide insights not previously reported. Our planned measurements as a function of pressure to search for a proposed metal-insulator transition will also be discussed.[1] J.M. Osorio-Guillen et al., Phys. Rev. B, 86 (2012) 235202[2] Y. Amagai et al., J. Appl. Phys., 96 (2004) 5644[3] Y. Imai and A. Watanabe, Intermetallics, 14 (2006) 722[4] N. Tsujii et al., J. Phys. Soc. Jpn., 77 (2008) 024705[5] U. Haussermann et al., J. Solid State Chem., 165 (2002) 94[6] Y. Hadano et al., J. Phys. Soc. Jpn., 78 (2009) 013702[7] E.M. Bittar et al., J. Phys. Conf. Ser., 200 (2010) 012014

Award :

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Supervisor :

Dr B.P. Doyle, bpdoyle@uj.ac.za, UJ

Paper :

Yes

Primary authors : Mr. AHMED, Mustafa (University of Johannesburg)

Co-authors : Dr. CARLESCHI, Emanuela (University of Johannesburg) ; Prof. HEARNE, GIOvanni (University of Johannesburg) ; Dr. SNYMAN, Jasper (University of Johannesburg) ; Dr. DOYLE, Bryan (University of Johannesburg)

Presenter : Mr. AHMED, Mustafa (University of Johannesburg)

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