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Size and Periodicity Dependant Magnetisation of Arrays of Nickel Nanodots

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Increasing demands for higher magnetic information storage capacity has made magnetic nanotechnology an intense and competitive field of research in recent years. The maximum achievable storage capacity depends upon the magnetization reversal of the storage material and its stability. The size, shape and behavior of magnetic domains as recording bits in the material are determining factors of such storage devices. Thanks to advances in nanofabrication, arrays of separated magnetic dots in comparable critical sizes in nanomagnetism can be fabricated by different techniques such as nanolithography. Recent results [1] show that magnetisation reversal of such magnetic nanodots can be investigated by several techniques like magnetic force microscopy (MFM) and magneto-optical Kerr magnetometry and reveal that magnetisation of dots fall into two major categories including single domain and vortex state magnetisation. We here demonstrate our results on nickel nanodot arrays with different size and periodicity by magnetic force microscopy (MFM) and magneto-optical Kerr magnetometry. Linear and grating arrays of nickel 100, 150 and 300 nm dots with different periodicities were fabricated by high-resolution electron beam lithography in a polymethlymethacrylate (PMMA) resist followed by metallization and lift-off in acetone. More technical details of the fabrication of our magnetic nanostructures can be found in [2]. Then, MFM was used to image the fabricated structures using an Asylum research MFP3D instrument. We used two different magnetic tips including standard (300-450 Oe coercivity) and low coercivity (<10 Oe) to image at different magnetic states.

There is a clear evidence of rotation of magnetisation from in-plane to out of plane. As MFM images of magnetised Ni dots show that white areas disappear and dark area form. A dipole coupling occurs when the periodicity of the array is small. However, small dots (100 nm with 10 nm thickness) are behaving as single domain magnets (Fig. 1), while for 150nm with 50 nm thickness an abrupt switching from vortex state to single domain can be seen partly due to the possible higher thickness of the dots.

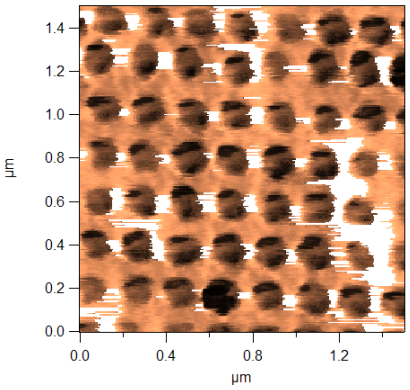

Fig. 1. MFM image of 100 nm nickel dots.

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Room-temperature Ferromagnetism in Tetragonal $Mn_{2-x}Cr_xAs$ Film Grown by Molecular-beam Epitaxy

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Epitaxial ferromagnetic(FM) or ferrimagnetic(FIM) thin films on semiconductor have recently attracted much interests for hybrid spintronic devices [1]. Arsenide (As) of transition metals with formula M2As (M= Mn, Fe, Cr) usually crystallize in three different crystal structures such as hexagonal (P-62m), tetragonal (P4/nmm) or orthorhombic (Pnma) structures. The most stable crystal structure of M_2As (M= Mn, Fe, Cr) is tetragonal, which exhibited antiferromagnetic(AFM) ordering at 573, 325, and 393 K, respectively[2]. The ternary $Mn_{2-x}Cr_xAs$ has complete solid solubility in the tetragonal (P4/nmm) crystal structure with antiferromagnets in the whole range of composition [3]. In epitaxial thin films on crystalline substrates, various crystallographic and magnetic phases other than those seen in bulk material have been predicted. From this point of view, the structure and/or magnetism of epitaxial $Mn_{2-x}Cr_xAs$ film might be very different from the previously reported this alloy. Here we report on the structural, magnetic, and magnetotransport properties of $Mn_{2-x}Cr_xAs$ thin film on GaAs(001) using a molecular beam epitaxy (MBE). From the magnetization and magnetotransport measurements we found evidence that the new ferromagnetism at room temperature in tetragonal $Mn_{2-x}Cr_xAs$ thin films.

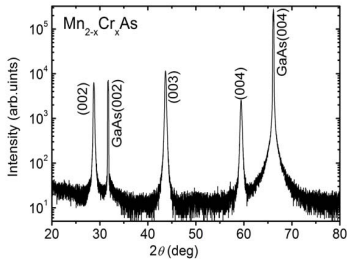

Fig. 1. θ-2θ XRD patterns of Mn2As-phase Mn2-xCrxAs film.

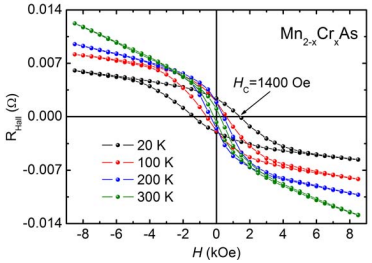

Fig. 2. Anomalous Hall resistance RHall of Mn2-xCrxAs.

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