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Strain induced new magnetic phase in $Fe_{2-x}Mn_xAs$

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Epitaxial ferromagnetic (FM) or ferrimagnetic (FIM) thin films on semiconductor have recently attracted much interests for hybrid spintronic devices. Arsenide (As) of transition metals with formula M_2As (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 with the lattice constants a = 3.769 Å/ c = 6.278 Å, a = 3.627 Å/ c = 5.973 Å, and a = 3.620 Å/ c = 6.330 Å, which exhibited antiferromagnetic (AFM) ordering at 573, 325, and 393 K, respectively [1-3]. On the other hand, the ternary $Mn_xFe_{2-x}As$ has complete solid solubility in the tetragonal (P4/nmm) crystal structure with peculiar magnetic properties. For the range 0 x 0.74 and 1.52 x 2.0, Fe_2As-type and Mn_2As-type AFM orderings were reported, respectively. For 0.74 x 1.29, AFM ordering was also observed but different from Fe_2As- and Mn_2As-types. Interestingly, in the range 1.29 x 1.52, a first-order phase transition at around T_s=165 K from a FIM phase to an AFM phase was reported. Structural and magnetic properties of epitaxial magnetic films turn out to be very sensitive to the strain caused by lattice mismatch and thermal expansion, etc. Some magnetic thin films have shown very different characteristics from bulk materials. Here we report on the structural and magnetic properties of $Mn_xFe_{2-x}As$(x=1.19) thin film on Si(001) substrate, exhibiting a FIM behavior above room temperature. The coercive field is 246 Oe at 300 K. With decreasing temperature, the saturation magnetization and the coercive field are increased.

References

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