Carnegie Mellon
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Materials Research at Carnegie Mellon

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"Ultrahigh Density Magnetic Recording Media: Time-Temperature-Transformation Diagrams for the A1 to L10 Transformation in FePt and FeCuPt Thin Films"

Friday, October 20, 2006
11:00 A.M. Seminar in Doherty Hall 1212
Refreshments precede seminar at 10:30 A.M. in 2325 Wean Hall

Further increases in the storage density of magnetic recording media to 1 Tb/in2 require materials with magnetocrystalline anisotropy energy density (MCA) greater than those of current Co-alloy media materials. The most likely candidate to replace the current alloys is L10 FePt, primarily due to its superior corrosion resistance compared to rare-earth alloys such as SmCo5. However, when deposited onto room temperature substrates, FePt films form in the metastable, chemically-disordered, A1 (fcc) phase, requiring post-deposition annealing at temperatures and times that are incompatible with current manufacturing requirements to transform to the desired L10 phase. This transformation occurs by nucleation and growth of ordered L10 domains in the A1 matrix; therefore the transformation can be described by an appropriate Johnson-Mehl-Avrami-Kolmogorov (JMAK) formulation, subsequently enabling the calculation of time-temperature-transformation (TTT) diagrams. These diagrams are constructed for a range of compositions in FePt and related ternary alloys from thermodynamic and kinetic data obtained using non-isothermal differential scanning calorimetry (DSC) of 1 μm-thick free-standing films. Additionally, experimental validation of the JMAK model is presented using isothermal DSC measurements of a partially transformed FeCuPt alloy. Parameters including but not limited to the density of nuclei, the interfacial energy, and the growth velocity are calculated, along with their compositional dependence. TTT diagrams comparing FePt binary alloys show that at low temperatures, Fe-rich films transform significantly faster than Pt-rich films. Lastly, a geometric correction factor is derived to extend the results from 1 μm-thick films to ultra-thin films on the order of 10 nm for magnetic recording media. For all alloy compositions, transformation in ultra-thin films results in longer times for any given temperature. -

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Dave received his Bachelor's degree in Materials Science and Engineering from The Pennsylvania State University in 2002 and his Master's degree in 2004 from Carnegie Mellon University. He is currently a Ph.D. candidate under the guidance of Prof. Barmak.