Moment Mapping of bcc Fe$_{1-x}$Mn$_x$ Alloy Films on MgO(001)

YVES IDZERDA, HARSH BHATKAR, Montana State Univ, ELKE ARENHOLZ, Advanced Light Source — The magnetic moments of ~20 nm single crystal films of compositionally graded Fe$_{1-x}$Mn$_x$ films (0.1 ≤ $x$ ≤ 0.2) grown on MgO(001) are determined by spatially resolved moment mapping using X-ray absorption spectroscopy (XAS) and magnetic circular dichroism (MCD). RHEED measurements confirmed that the growth of Fe$_{1-x}$Mn$_x$ films remained epitaxial and in the bcc phase up to $x=0.35$ but, like Fe growth, is rotated 45 degree with respect to the MgO(001) surface net. This is beyond the bulk bcc stability limit of $x=0.12$. Both magnetometry and XMCD measurements show that the net magnetic moment of these alloy films behave similarly to the bulk behavior, with a gradual moment reduction at low Mn concentrations followed by an abrupt departure from the Slater-Pauling curve and disappearance of the moment at $x=0.15$. By generating a compositional variation around this critical concentration and subsequently using spatially resolved mapping of the X-ray absorption at the Fe and Mn L$_3$-edge using linear and circular polarized soft X-rays, the local composition and elemental moments can be simultaneously mapped across the surface of the sample. The Fe moment is found to gradually reduce with increasing Mn content with a very abrupt decline at $x=0.15$. Surprisingly, the Mn moment shows a very small net moment (<0.1 $\mu_B$) at all compositions, suggesting a complicated Mn spin structure.