Origin of Giant Saturation Magnetization in Fe$_{16}$N$_2$ thin film

JIAN-PING WANG, NIAN JI, XIAOQI LIU, YUNHAO XU, Center for Micromagnetics and Information Technologies, University of Minnesota, C. SANCHEZ-HANKE, NSLS, Brookhaven National Laboratory — Can localized 3d electron exist in strong ferromagnetic metal because of some unusual correlation effect? This question is related to the controversy on whether α”- Fe$_{16}$N$_2$ has giant saturation magnetization which has been debated for decades since its first observation$^{1,2}$. Here we report the synthesis of α”- Fe$_{16}$N$_2$ thin films. The highest moment is obtained to be 3.0$\mu_B$/Fe. XMCD experiment is systematically performed on a series of iron nitrides samples. Among all the iron nitrides phases, it is found that there exist highly localized 3d electrons only in chemically disordered Fe$_8$N and ordered F$_{16}$N$_2$ phases$^3$. This discovery hints at the origin of the giant magnetic moment is correlated with the 3d electron localization in such system. First principle calculation (LDA+U) further verifies that the d electron localization is the key element to rationalize the high moment formation in iron nitrides system$^4$. We also provide a speculative outlook on the giant saturation magnetization formation based on “cluster + atom” concept.