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The rare-earth nitride (REN) series has attracted considerable research interest because of the co-existence of semiconducting and ferromagnetic properties, a feature ideal for spintronic devices. Dysprosium nitride (DyN) is a promising candidate whose electronic structure is relatively well understood. However, its magnetic structure has received little attention until recently. In particular, its low temperature bulk magnetic moment of about 4 $\mu\text{B}/\text{ion}$ is significantly lower than the predicted magnetic moment, which is much closer to the free-ion value of 10 $\mu\text{B}/\text{ion}$ [1]. Because of this, we are attempting to understand the detailed magnetic structure of DyN using conventional magnetometry combined with ^{161}Dy Mössbauer spectroscopy.

Using ion-assisted deposition, we have grown thick 3-4 μm DyN films on both sapphire and Kapton substrates. Because the characteristic measurement time for ^{161}Dy Mössbauer spectroscopy is of the order of nanoseconds, the spectrum recorded at 5 K was sensitive to rapid thermal fluctuation between the low-lying levels of the Dy $^{3+}$ crystal field scheme. The spectrum was successfully analysed in terms of flipping between a pair of levels with moments of the same magnitude, 10 μB , but opposite sign. Based on the fitted energy separation, the longer-time, thermal-averaged moment can be estimated at about 85% of the full free ion value. However, such a simple 2-level crystal field ground state model would require a breaking of the cubic symmetry appropriate for the Dy $^{3+}$ site in bulk DyN.

References:

[1] D. L. Cortie et. al., Phys. Rev. B 89, 064424 (2014)

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