Magnetic Properties of Coupled Ni/Gd Bilayers

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• There is great demand in the magnetic recording industry to find high magnetization, low anisotropy materials in order to write high anisotropy media required for thermal stability at small bit sizes.
• Rare-earths offer the possibility of high magnetization from their partially filled f-electronic shells.
• Among the rare earths, the Gd is particularly important since it has an intrinsically low anisotropy from its half-filled f-electronic shell so it does not significantly alter the magnetic damping which is important to retain a high frequency response for the write-head application.

Here we report the magnetic and structural properties of Ni(10nm)/Gd(20nm) bilayer grown on Si substrate with Nb used as seed and capping layer.

• The Gd magnetization drops much faster than the Ni one with the increase in temperature since it has a Tc much lower than the Ni one.
• As the temperature increases from 5 K to 50 K the remanent magnetic moment decreases since the Ni and Gd magnetization couple antiferromagnetically at the interface and the Gd magnetic moment is higher than the Ni one in the temperature range 5-50K.

• X-ray diffraction data
  • Nb grows in the (110) direction, Ni grows in the (111) direction, and Gd layer grows in the (10-10) direction.
  • The Gd peak is very small which indicates the lack of long range atomic ordering in the Gd film.

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• Polarized Neutron Reflectivity at T=5 K and H= 100 Oe
  • From the fit the magnetization of the Ni and Gd layers are around 480 and 930 emu/cc respectively, and the moment of the Gd layer align parallel to the field while the moment of the Ni layer is in the opposite direction which confirm the antiferromagnetic coupling between Ni and Gd.

• Polarized Neutron Reflectivity at T=5 K and H= 7900 Oe
  • From the fit the magnetizations of Ni and Gd are around 480emu/cc and 1100emu/cc respectively.
  • The magnetization of both layers is aligned to the field direction.
  • This slight difference of the VSM and PNR values of the magnetization may be due to film thickness variations from the deposition geometry.

• The magnetization of Ni and Gd exhibit antiferromagnetic coupling at the interface. This result was confirmed both by low temperature vibrating sample magnetometry and by polarized neutron reflectivity measurements.
• Tc reduction of the Gd film is probably due to the lack of long range atomic ordering.
• Future experiments will focus on trying to produce FM/RE film stacks with ferromagnetic alignment.

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