The following is the report of the NRI Liaison Team review of the NRI-NSF activities at the University of Alabama on Sept. 9, 2010.

NRI Liaisons attending in person: Allen Bowling, TI; Zoran Krivokapic, GlobalFoundries;
NRI Liaisons attending by phone/Webex: Ajey Jacob, Intel; Steve Kramer, Micron; Daniel Worledge, IBM; June Lau, NIST;
U. Alabama attendees: Prof. Arun Gupta, Prof. Patrick LeClair, Post-Doc Dipanjan Mazumdar, several graduate students
Presentations from the review are on the NRI website.

The UA team gave a background of their magnetic-storage NSF work. In 2001, Prof. Bill Bulter (U. Alabama) demonstrated Spin Coherent Tunneling with Fe / MgO / Fe (or FeCo / MgO / Fe). The best TMR results today (600%) are achieved with CoFeB / MgO / CoFeB. They are assessing possibilities for switching to a magnetic barrier material to replace the MgO.

The UA team then described their efforts to test materials for spin injection and spin polarization (spin filtering). They have been testing magnetic insulators with high Tc, so that there are prospects of doing this at or near room temperature. They have looked at double perovskites, e.g. La2NiMnO6. They have also looked at a more promising group of spinels: NiFe2O4 (NFO) and CoFe2O4 (CFO). For NFO and CFO, they have been doing depositions on MgAl2O4 with pulsed laser deposition (PLD) – they must grow high-quality epitaxial films that are defect free, with magnetization preserved down to the unit cell. The PLD system uses a KrF excimer later (248nm), and they have an in-situ RHEED system for making measurements during growth. PLD depositions in ozone have given best results to date; films deposited at around 550 C have given the best electronic properties. They have also worked on single spin filter devices of STO substrate / LaSrMnO (LSMO) 30 nm pinned layer / STO 3 nm barrier / NFO 3nm layer. They have patterned structures with 1 um features and measured a 3 eV bandgap and tested TMR at 77 K. They recognize that they must evaluate different materials to replace LSMO to move towards room temperature. They want to look at other composite materials; Prof. Gupta indicated a plan to fabricate and study spin filter devices with thin barrier layers (bilayers) of different composition and structure, e.g. SrTiO3 and NiFe2O4, NiFe2O4, CoFe2O4, etc.

NRI Liaison Team Feedback:

- This is a unique program important for its materials efforts – to help assess real materials for spin injection and spin polarization/filtering. No other center appears to have these same materials capabilities; this is a great leverage of their NSF-funded magnetic storage materials activities. So, the NRI Liaison Team recommends that we continue to fund this work because of their unique capabilities, but to also try to link this group with other NRI centers working on spin logic devices (e.g. INDEX and WIN) so that INDEX and WIN can give them more inputs of the materials properties needed to help focus the Alabama team's efforts; Zoran and Ajay agreed to help give them some contact points. Ajay also agreed to give a presentation to their team on the device requirements for spin devices. The NRI Liaison Team was especially pleased that they had tried to build an actual spin filter structure in this past year; this type of experimental effort, to supplement the theory, is exactly what is needed.
- The NRI Liaison Team gave some feedback on additional things they should try:
    - Agreed they should fabricate and study spin filter devices with thin barrier layers (bilayers) of different composition as noted above.
    - They should look at system thermal variation
    - They should look at damping measurements of the materials (Ajay indicated a willingness to help with this)
    - High-frequency operation is important; new ideas are needed to reduce the resistance in order to increase the read-speed
    - Measure if the anti-phase boundaries sites have a significant impact on performance

Regards,
Allen Bowling, TI