PETER update meeting

2020/08/27

Attendees: Alisa Leavesley, Richard Wylde, Kevin Pike, Tomas Sikola, Rainer Hillenbrand, Joris van Slageren, Dominik Bloos, Lorenzo Tesi, Petr Neugebauer, Martin Hrton, Martin Konecnv (AFM), Bozena Cechalova, Jan Cechal, Zdenek Novacek, Michal Pavera, Elizaveta Nikulina

Agenda:

1.       Progress in PE EPR spectroscopy experiments/simulations – USTUTT/BUT

2.       Progress in fabrication of probes – BUT/NanoGune

3.       Present state on testing of AFM in Stuttgart – USTUTT (M. Konečný)

4.       Samples for PE EPR spectroscopy and microscopy – Stuttgart /BUT/NanoGune

5.       Signal modulation issue – TK

6.       Project management and admin – BUT

7.       Miscellaneous

Meeting Minutes:

1. PE EPR
   1. LT: Simple HF EPR test: Pellet of Mn12ax (30 mg), see signal at 294 GHz/1.5 T & 310 GHz/2 T; heating from modulation coil is issue; EPR works in the PETER spectrometer! Need to improve alignment and thermal stabilization. Paper will be shortly sent around for review on PE EPR spectroscopy based on previous results.
   2. MH: additional measurements with just the sample + holder without cooling/magnetic field were asked for to help with simulations - USTUTT did these. Delayed in producing results because trying to finish thesis (magnetization relation to near field, will result in another paper) – more effort will occur moving forward.
2. Probe
   1. EN: NGU to attempt to get smooth surfaces for the pyramid tips, use Ga ion beam (20x smaller than Xe ion beam) – takes 5-6 hrs per probe; Xe ion beam is ‘fast’ but produces rough surface. With pre-fabricated pyramid takes 3 hrs to polish the tip to a smooth surface vs. 5-6 hrs from scratch. 7 tips have been made and sent to Brno on 14.08.2020
   2. ZN: But has received the NGU tips, depositing AU layer now; processing next week to remove excess gold to form the antenna 🡪 in ~3 weeks send tips to USTUTT
   3. TS: can polishing be accomplished directly at BUT via Xe beam? Some challenges are present to do so
   4. RH: there is no issue for NGU to do the polishing: i.e. BUT does rough cut & NGU polishes 🡪 this is the goal teaming up to solve problems
   5. Have glass tips been tested in the set up? – TS says yes a few in USTUTT, MK: has some probes on site at USTUTT, some glass fiber tips and Akiyama tips, ZN: chemical etched glass fiber on tuning fork is at USTUTT; RH: these sharp tips give good images, but have not determined the final curvature of the apex of tip, RH has no idea how good the AFM tip performance will be. It would then be good to test some of these glass fiber tips without the antenna on it – recommend to test/figure out SNR and general AFM performance for stable AFM imaging. This would allow us to figure out what the idea tip bluntness/size should be to make sure efforts are the most efficient; ZN: tested one of the FIB blunted tips, it worked, but did not test extensively as the final dimensions have not been finalized.
   6. RH: we should finalize the tip diameter (not sure how achievable it is to polish a wide diameter tip – it is easy to do for sharp tips); TS: current tips are estimated to be 500 nm after FIB. RH: do we want them to be spherical or pyramidal? Pointed tip will be better from a mechanical POV; EN: metallic tips it is easier to make sharper tips, glass not sure. TS: will measure the tips EN sent to BUT - check size; ZN: see signal with broken blunt tips – do not need very sharp tips; RH: concern about optics and current through the tip – we need to define this well, prevent irregularities in the tip optics to extend the life of the tip (use Pt instead of Au?) Need to minimize the unknowns of why something is not working, need to optimize each step as much as possible. TS: Say make three test tips 1 um, 500 nm, and 2 um tip diameters to test the tip performance (maybe go down to 100 nm too?)
3. AFM testing
   1. MK: at USTUTT since August 2020; 1st check SPM is working properly. Initially issues with z-stepping motor – now fixed. First tests with Akiyama probes to make sure it should work –try RT and air, 2nd try tuning fork probe with etched glass fiber tip in RT and air (tip made by etching in HF) – able to get calibration from the SPM; 3rd go to 77 K in 20 mbar He atmosphere – able to measure, but the scanning range of the piezos is reduced by a factor of ~2, scanning range can be made larger by applying higher voltages. The image quality is worse than in air – reason is due to vibrations from the vacuum tubing for the vacuum pump. When the pump is off – get nice images even at 10 K (but no pump – no stable temperature). Preforming trace and retrace to make sure the feedback is not influencing the system in terms of direction of measurement
   2. RH: vibrations from pump is definitely a concern, but image is still too blurred & faint – there could be a feedback or charging effects/issues because it is not in contact with the sample. This seems like it is more topography (far away 100s nm), but to do optical measurements/near-field we would need to be in contact (much closer) – here tip does not appear to be in contact with the sample. Need good tip/optic/contact mechanics to make sure this will work. Mechanics are critical to be able to get good optical signal; therefore, need to get amazing topography because any issues in topography will be magnified for any optical measurements
   3. ZN: working in tapping mode to acquire the signal; so do not believe the tip is 100s nm away. Thinks the z-scale is wrong. As left side is sharper than right side 🡪 low feedback gain that needs to be adjusted
4. Samples to be tested
   1. JS: Mn12 is test sample for the optics, radicals in polymer, & self-assembled mono-layers directly on the antennas (due to COVID-19, this last one is now on a back burner)
   2. JC: thermal evaporation to make continuous layers, and spitting cells to make isolated microcrystals (option to prepared samples for microscopy setup); tried and failed on DM18N and Cu(bdm)2 – which decomposed during the process; now testing FePc (Fe Pthalocyanine), which seems to be working
   3. TS: prepare samples of FePc for both spectroscopy and microscopy – JC needs the specifications for the samples to do so; JS will discuss and define with BUT
   4. EN: ortho-ferrite (BIFeO3 film on SiC) BUT prepared and NGU measured – goal: to check the magnetic response in THz. Literature see responses at 2.4 THz, & 530, 560, and 740 GHz but for signal crystal sample. Polycrystalline sample was provided, see some holes in the sample via SEM, i.e. not homogeneous with many defects (pores and dislocations), via EDX see some Bi2O3 crystals; first experiment see some peaks, but do these change as a function of magnetic field? Use a 2 mm Nd magnet and Al spacer to make sure samples are level. Sample is ½ on spacer and ½ on magnet. Has a 100 um resolution. Should see signal of BFO magnons (expect 3 peaks), but 2 of them overlap with the water lines, the 3rd one is not visible and is very weak in literature; issues could be film thickness (too thin), and quality of film as well as the H20 lines. (try to run under N2/Ar environment?) Orientation of the crystal is also key in literature – if polycrystalline may cancel out – may need single crystal
   5. JS: magnet field may not be helpful if polycrystalline. Possible to remove H20 lines via inert environment - send sample to USTUTT to test if the sample thickness produces an EPR response
   6. RH: single crystals are not easy; NiO possibility (start with powder – but waiting since April for sample – expected delivery now September) – is it possible to get more of YFeO3 powder? – try to mix with PMMA / resin to make a homogeneous sample
5. Modulation issue
   1. AL: explain modulation issue and possible solutions (circuit not meet requirements of amplifier – needs minimum of 2 Ohm and coil is <1 Ohm 🡪 amplifier cannot perform properly – lead to cutting out and heating effects) – issue is being discussed directly with USTUTT – possible visit to USTUTT around Sept 15
6. Admin stuff
   1. BC: Amendment for the extension of the project due to COVID – need updated work person months for each partner for the remaining WPs; will being discussion with PO in September and should be ready to submit in the first week or so of September. Push due dates for D1.7 and D2.6 back 6-9 months – now month 36-39 – end of March 2021 is ideal. For optimized tips deliverable– we have optimized their fabrication but not yet their function/actual parameters (JS we do not need to show that they technically work)
   2. Outlook on publications – LT is working on one now; but we need to improve the number of publications associated with the project to meet our promised dissemination outputs (USTUTT has results for at least 2 papers); do we publish simulation/theoretical only papers? – RH: dependent on the quality of the journal – generally better for one larger full concept paper with proof from experiments and confirmed by simulations than a bunch of smaller papers
   3. Other dissemination activities – video clip for introduction to PETER once it is running smoothly & a press release – need to disseminate to the general public
7. Miscellaneous
   1. Meeting to discuss Launchpad proposal on 04/08/2020 at 2 PM CET – budget and person months for work packages