NANOFABRICATION OF 30NM PILLARS FOR CURRENT INDUCED SWITCHING DEVICES

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Electron-beam lithography conditions and resist are optimized aiming at the nanofabrication of current perpendicular to plane (CPP) pillar devices with 30 nm critical dimensions for spintronics.

Small features (less than 30nm) patterned by e-beam lithography are usually defined through a positive resist. However, a CPP device requires the patterning of nanopillars, and the exposure of a dense mask with over 500 devices in a 2x2 cm2 area becomes very time consuming, as the beam scans over the entire wafer area. This work combines a RAITH-150 tool with a negative e-beam resist (AR-7020.18). A negative resist is chosen to improve the wafer throughput (typically, 40 min to expose over 500 devices), while maintaining the high resolution for pillar patterning with less than 40nm dimensions. The resist dilution and coating conditions are optimized, aiming at its thickness reduction from the 200nm down to 80nm. The exposure parameters were tuned for different geometries and dimensions, so that features down to 30nm are exposed with good accuracy (±1.9nm) and reproducibility. The contrast, optimum exposure dose, develop time and etch rate (using an Ar^+ beam) are obtained for the different resist dilutions.

The complete integration of these nanoelements into CPP devices involved electron beam lithography combined with etching by ion milling to define the MTJ pillar and Chemical Mechanical Polishing (CMP) [1]. Results on devices incorporating magnetic tunnel junction (MTJ) structures deposited by Ion beam [2] are shown. The films have the structure: glass or Si/Al_2O_3 50nm substrate//Ta 5nm/Ru 20nm/Ta 5nm/$Mn_{78}Ir_{22}$ 15nm/ $Co_{90}Fe_{10}$3nm/Ru 0.8nm/$Co_{56}Fe_{24}B_{20}$ 4nm/MgO 0.8nm /$Co_{56}Fe_{24}B_{20}$ 3nm/Ru 3nm/Ta 5nm,, and the MgO deposition conditions were optimized to obtain final devices with tunnel magnetoresistance TMR ranging from 20-40%, with resistance-area products RxA of ~ 1 $\Omega.\mu m^2$.

The nanofabricated pillar devices are characterized in terms of resistance dependence on the 1/Area. Finally, the transfer curves under dc magnetic fields and spin transfer measurements (current induced switching) will be shown.

[1] R.J. Macedo, J. Sampaio, J. Loureiro, P. Wisniowski, S. Cardoso, P.P. Freitas, M.MacKenzie and J.Chapman, IEEE Trans.Nanotech. (in print 2008)
[2] S. Cardoso, R. Macedo, R. Ferreira, A. Augusto, P. Wisniowski and P.P. Freitas, J.Appl.Phys. **103**, 07A905 (2008)