Josephson and Multi-Gap Quasi-Particle Tunneling in Crystalline MgB$_2$-based Junctions with an MgO Sputtered Barrier

JEAN-BAPTISTE LALOE, MIT, J. S. MOODERA, SCTF TEAM — MgB$_2$ is a multi-gap superconductor with a $T_C$ of 39K and a hexagonal structure. This simple and stable compound is very attractive for device applications. We have deposited and patterned micron-sized SIS tunnel junctions with highly textured MgB$_2$ electrodes grown by MBE co-evaporation with sputter-deposited MgO tunnel barriers, in an entirely in-situ process. This method enabled us to obtain low resistance junctions with very good oxide coverage. We present $I - V$ and $dI/dV$ data displaying Josephson pair tunneling as well as the quasi-particle tunneling signature of both the Pi- and Sigma-bands of the MgB$_2$. Our experimental gap values agree with theoretical calculations. Although our MgB$_2$ films were $c$-axis oriented, growth-related roughness of the bottom MgB$_2$ enable $a/b$-axis tunneling and thus explain the observed Sigma-band features. We link our data to a simple model assuming tunneling to occur from both the Pi- and Sigma-bands in parallel, proportionally weighted depending on the interfacial topography.

$^1$Work supported by ONR Grant N00014-061-0158