Superconducting energy gap features of MgB$_2$ thin films on different substrates and orientations

WENQING DAI, QI LI, Department of Physics, The Pennsylvania State University, University Park, PA 16802, KE CHEN, XIAOXING XI, Department of Physics, Temple University, Philadelphia, PA 19122 — We report a detailed study of tunneling spectra of MgB$_2$/I/Pb planar junctions with MgB$_2$ films on various substrates and of various doping levels. Planar trilayer junctions were fabricated using MgB$_2$ films with native oxide barrier grown by the Hybrid Physical-Chemical Vapor Deposition technique. Both $\pi$ and $\sigma$ bands contribute to the tunneling spectra of tilted-axis films on MgO (211) substrate and mainly $\pi$ band was observed on c-axis MgB$_2$ films on SiC (0001), MgO (111) and c-sapphire substrates. We observed $\sigma$ gap value of $\sim$7.9 meV in MgB$_2$ films on SiC substrates which display higher $T_c$ due to the lattice strain. This is larger than 7.4 meV on unstrained substrates. However, the $\pi$ gap value of all samples is $\sim$2.3 meV. We concluded that the strain in MgB$_2$ films on SiC substrates mainly affects the $\sigma$ band of MgB$_2$. In addition, small amount of nitrogen gas was added during film growth to introduce more scattering in MgB$_2$ films. We systematically studied the change of two gaps with nitrogen doping from the tunneling spectra of MgB2/I/Pb junctions.

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