Far-infrared Studies of the Two-Gap Behavior in Epitaxial MgB$_2$ Films$^1$ JIUFENG TU, The City College of New York, G.L. CARR, BNL, R.P.S.M. LOBO, ESPCI, P. ORGIANI, X.X. XI, Penn State — Far-infrared transmission and reflectivity measurements have been carried out for a series of pure and carbon-doped epitaxial MgB$_2$ films. While the carbon-doped film exhibits the typical characteristics for a dirty BCS superconductor in the $T_S/T_N$ and $R_S/R_N$ ratios, the pure MgB$_2$ films can only be understood knowing the multi-gap nature of the superconducting state in MgB$_2$. As a function of increasing $T_c$, the fraction of the Cooper pairs having the larger gap increases. Both gaps appear to follow the BCS temperature dependence. However, the two gaps exhibit different behavior when a magnetic field is applied along c-axis. While the smaller gap can be suppressed by a relatively small field, the larger gap can persist up to 10 T. These infrared measurements indicate that the two superfluids coexist quite independently in the superconducting state of MgB$_2$.

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