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Evolution of two-gap superconductivity of MgB_2 by Al substitution MIN-SEOK PARK, HEON-JUNG KIM, HYE-GYONG LEE, National Creative Research Initiative Center for Superconductivity & Department of Physics, Pohang University of Science and Technology, MYUNG-HWA JUNG, YOUNGHUN JO, Quantum Material Laboratory, Korea Basic Science Institute, DaeJeon 305-333, Republic of Korea, SUNG-IK LEE, National Creative Research Initiative Center for Superconductivity & Department of Physics, Pohang University of Science and Technology, MIN-SEOK PARK, HEON-JUNG KIM, HYE-GYONG LEE, AND SUNG-IK LEE TEAM, MYUNG-HWA JUNG, YOUNGHUN JO, AND SUNG-IK LEE COLLABORATION — The temperature dependence of the upper critical fields ($H_{c2}(T)$) of the two-gap superconductors $Mg_{1-x}Al_xB_2$ not only for low doping level ($x < 0.1$) but also for high doping level ($0.1 \leq x \leq 0.3$) was obtained by resistivity measurements. The $H_{c2}(T)$ values were analyzed, within the dirty-limit two-gap model, using the calculated electron-phonon coupling constants and Coulomb pseudo potentials. As the Al contents increased, both T_c and $H_{c2}(0)$ decreased, which was the direct manifestation of the increasing number of electrons. At the same time, the three-dimensional π bands became much dirtier when Al was doped. In contrast, the intraband scattering of the two-dimensional σ bands was relatively unaffected by the Al doping. These behaviors could be understood when the characters of both bands were considered. In all the samples that we investigated, the σ bands were dirtier than the π bands.

Min-Seok Park
National Creative Research Initiative Center
for Superconductivity & Dept. of Physics, Pohang University of Science and Technology
Pohang 790-784

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