Comparative Study of Impurity Scattering on Al-and C-doped MgB_2 Single Crstals

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We investigated the temperature dependence of the upper critical fields H_{c2}(T) of Al- and C-substituted MgB_2 single crystals along the two main crystallographic directions. Despite similar suppression of T_c with the Al and C concentrations, the effects of the two substitutions on H_{c2}(T) are found to be different. H_{c2}(T) of the Al- and the C-doped MgB_2 can be well explained within the dirty-limit two-gap theory though H_{c2}(0) of two substitutions show an opposite behavior, indicating very weak interband scattering. For the C-doping case, the ratio of in-plane electron diffusivities D_σ/D_π is much smaller than that for the Al-doping case indicating that C-doping enhances impurity scattering mainly in the σ bands as anticipated. The ratio of H_{c2} along the two directions, γ_H(T) (= H_{c2}^{ab} / H_{c2}^{c}) systematically decreases with both Al and C dopings, however, γ_H(T) for the C-doped shows a stronger temperature dependence than that for the Al-doped MgB_2 crystals.

Keywords : MgB_2 single crystals, Al doping, C doping, impurity scattering