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Clean and Dirty MgB_2 Thin Films by Hybrid Physical-Chemical Vapor Deposition[1]

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The interband and intraband scattering in MgB_2 have significant influences on various properties of this two-band superconductor. In order to explore new physical phenomena and realize the potential for applications in MgB_2, it is desirable to control the interband and intraband scattering arbitrarily and independently. Hybrid physical-chemical vapor deposition (HPCVD) is a promising technique towards this goal. It has produced very clean MgB_2 films with a residual resistivity ratio of 60. The tensile strain in the films due to crystallite coalescence results in a softening of the E_{2g} phonon and higher-than-bulk T_c values. The long mean free path of the films, which are the cleanest MgB_2 materials reported, allow magnetoresistance measurements that reveal rich features of the two-band Fermi surfaces. The HPCVD technique also allows doping of the clean films in a controlled manner, which modifies the interband and intraband scattering and results in record-high upper critical field H_{c2} of over 60 T. The demonstrations of HPCVD for high quality polycrystalline coatings on coated conductor fibers, high deposition speed and thick films, and on various polycrystalline substrates make it a promising technology for high field applications of MgB_2.

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