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Magnetic and non-magnetic substitutions in MgB_2 single crystals: influence on superconducting properties and structure JANUSZ KARPINSKI, NIKOLAI D ZHIGADLO, KRZYSZTOF ROGACKI, BERTRAM BATLOGG, GETZ SCHUCK, Laboratory for Solid State Physics ETH Zurich , ROMAN PUZNIAK, ANDRZEJ WISNIEWSKI, Institute of Physics PAS Warsaw , RENATO GONNELLI, Politecnico di Torino — Pure and substituted single crystals of MgB_2have been grown at high pressure (30 kbar) using the cubic anvil technique. The crystals have very low residual resistivity ρ_o(40 K)$\approx$0.5 and a sharp transition $\Delta T_c \approx$0.2 K. Magnetic (Mn, Fe) and non-magnetic (Al, C) ions have been substituted to study their effect on superconductivity and on the impurity scattering in and between the σ and π bands. Single-phase $Mg_{1-x}Al_xB_2$ and $MgB_{2-x}C_x$ crystals were grown for x=0-0.3. Al and C cause a similar moderate decrease of T_c. Magnetic ions, such as Fe^{3+} and Mn^{2+} suppress T_c very effectively, due to magnetic pair breaking. Superconductivity is completely suppressed for by 2% Mn. Fe substitution decreases T_c less rapidly than Mn but much faster than Al and C. Carbon substitution increases the H_{c2} twice, while Al, Fe and Mn substitutions decrease this field. H_{c2} anisotropy decreases with all substitutions, but the temperature dependence of the anisotropy is different, due to different scattering rates in the π and σ bands. For Mn and Al, π and σ energy gaps exist up to the highest substitution level, while for C substitution, merging of these gaps is observed indicating interband scattering.

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