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Tuning the Superconducting Properties of MgB_2

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The relatively high superconducting transition temperature of 39 K in MgB_2 has garnered much interest over the past several years in both fundamental and applied research. MgB_2 is a conventional phonon mediated BCS superconductor with the unconventional property of two superconducting gaps. These gaps (σ and π) arise from the coupling of boron phonons with two different orthogonal sheets of the Fermi surface. In a conventional single gap superconductor the upper critical field can be tuned by the introduction of nonmagnetic impurities. For MgB_2 the situation becomes more complex because there are 3 important scattering channels (inter and intra-band). Theoretical calculations predict different developments of the upper critical field and anisotropy ratio if the scattering can be selectively tuned to a specific channel. In this talk I will present data on two different types of perturbations to MgB_2: carbon doping and neutron irradiation. Low level carbon doping enhances the upper critical field with only a minor decrease in T_c. Whereas T_c suppression is the result of carbon electron doping the system, the enhancement of $H_{c2}(T=0)$ is the result of an increase in scattering, with evidence to suggest carbon doping enhances intra-π-band scattering. In contrast, $H_{c2}(T=0)$ values tend to scale with T_c in heavily neutron irradiated samples and the superconducting properties can be understood in terms of a decrease in the density of states at the Fermi surface and an increase in interband scattering.