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Inhomogeneous Nanoscale Disorder in Doped Magnesium Diboride[1]

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Using TEM and STEM imaging and microanalysis, we have shown that doped MgB_2 has a variety of forms of disorder at a length scale of 5-50 nm. In [0001]-normal, carbon-doped HPCVD thin films, there is a thin, amorphous, C-rich layer which separates domains of lightly carbon-doped MgB_2. Carbon also causes significant spread in the local in-plane orientation and c-axis direction of the MgB_2. We also observed disorder in the orientation of small MgB_2 domains in oxygen-doped thin films grown by MBE. Both of types of films show dramatic enhancement in the upper critical magnetic field compared to pure MgB_2, with extrapolated $H_{c2}(0\ K)$ reaching 65-70 T for some samples. The origin of this increase may be in the observed disorder, particularly in confinement of the superconducting MgB_2 domains by non-superconducting second phase layers.

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