

**INFLUENCE OF CHEMICAL SUBSTITUTIONS ON  
ANISOTROPIC UPPER CRITICAL FIELD IN MgB<sub>2</sub>: IMPACT  
OF FERMI SURFACE CHANGES**

**R. Puzniak<sup>a</sup>, A. Wisniewski<sup>a</sup>, J. Jun,<sup>b</sup> S.M. Kazakov<sup>b</sup>, J. Karpinski<sup>b</sup>**

<sup>a</sup>Institute of Physics, Polish Academy of Sciences, PL 02-668 Warsaw, Poland

<sup>b</sup>Solid State Physics Laboratory, ETH Zurich, CH-8093 Zurich, Switzerland

Specific band structure of MgB<sub>2</sub>, with two bands  $\pi$  and  $\sigma$  involved in superconductivity, leads to high critical temperature,  $T_c$ , of 39 K and temperature and field dependent anisotropy of superconducting parameters. Chemical substitutions lead to modification of band structure and therefore influence all superconducting parameters, especially  $T_c$ , the upper critical field,  $H_{c2}$ , and its anisotropy,  $\gamma_H$ . Magnetic investigations of Mg<sub>1-x</sub>Al<sub>x</sub>B<sub>2</sub> crystals show the slight increase of  $H_{c2||c}$  for the samples with small  $x$ , significant reduction of  $\gamma_H$  at lower temperatures for Al substituted samples as compared to this of unsubstituted crystals. In Mg(B<sub>0.94</sub>C<sub>0.06</sub>)<sub>2</sub> single crystals  $H_{c2||c}(0) \cong 85$  kOe is more than twice as large as that one of  $\cong 31$  kOe in unsubstituted MgB<sub>2</sub>. Anisotropy of  $H_{c2}$  decreases to about 4 at low temperatures, the value considerably lower than that in MgB<sub>2</sub>, and its temperature dependence is much less pronounced. The corresponding  $H_{c2||ab}(0) \approx 330-350$  kOe is likely close to the maximum enhancement of  $H_{c2}$  due to chemical substitutions. The enhancement of  $H_{c2}$  can be explained as a disorder effect only if the main result of disorder is to make the  $\pi$  bands more dirty while not affecting the  $\sigma$  bands as much. However, in addition to disorder and weakened electron-phonon coupling, the impact of the Fermi level shifting into a region with lower  $\sigma$  Fermi surface velocities has to be taken into account in the analysis of  $H_{c2}$  data as well.

9.7 cm

13.4 cm

**Subject category :**

1. Correlated Electrons and High Temperature Superconductors

**Presentation mode :**

oral

**Corresponding author :**

Roman Puzniak

**Address for correspondence :**

Institute of Physics  
Polish Academy of Sciences  
Al. Lotnikow 32/46  
02-668 Warsaw  
Poland

**Email address :**

puzni@ifpan.edu.pl