Defect induced magnetism in SiC

Yutian Wang, Yu Liu, Sybille Gemming,
Manfred Helm, **Shengqiang Zhou**

Helmholtz-Zentrum Dresden-Rossendorf, Dresden, 01328, Germany

Defect-induced magnetism is attracting intensive research interest. It not only challenges the traditional opinions about magnetism, but also has some potential applications in spin-electronics. SiC is a new candidate for the investigation of defect-induced ferromagnetism after graphitic materials and oxides due to its high material purity and crystalline quality [1, 2]. In this contribution, we made a comprehensive investigation on the structural and magnetic properties of ion implanted and neutron irradiated SiC sample. In combination with X-ray absorption spectroscopy and first-principles calculations, we try to understand the mechanism in a microscopic picture.

For neon or xenon ion implanted SiC, we identify a multi-magnetic-phase nature [3]. The magnetization of SiC can be decomposed into paramagnetic, superparamagnetic and ferromagnetic contributions. The ferromagnetic contribution persists well above room temperature and exhibits a pronounced magnetic anisotropy. By combining X-ray magnetic circular dichroism and first-principles calculations, we clarify that p-electrons of the nearest-neighbor carbon atoms around divacancies are mainly responsible for the long-range ferromagnetic coupling [4]. Thus, we provide a correlation between the collective magnetic phenomena and the specific electrons/orbitals.

With the aim to verify if a sample containing defects through its bulk volume can persist ferromagnetic coupling, we applied neutron irradiation to introduce defects into SiC [5]. Besides a weak ferromagnetic contribution, we observe a strong paramagnetism, scaling up with the neutron fluence. The ferromagnetic contribution only occurs in a narrow fluence window or after annealing. We speculate that defect-induced ferromagnetism rather locally appears in particular regions, like surface/interface/grain boundaries.

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