The role of hydrogen in room-temperature ferromagnetism at graphite surfaces

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The existence of long range magnetic order at ambient temperatures in carbon based structures without magnetic elements is unexpected and therefore attracted the attention of the solid state community over the past years. Theoretical results from different groups suggest that the existence of long range magnetic order in a graphite structure is possible, if one takes the effects of defects and/or the incorporation of hydrogen atoms on the electronic properties into account. SQUID results provided first systematic hints for the existence of magnetic order at room temperature in virgin [1] as well as proton- or carbon-irradiated [2,3] highly oriented pyrolytic graphite (HOPG) samples. Magnetotransport measurements reveal that the samples indeed show an anisotropic magneto resistance caused by the ferromagnetic order. In this contribution we present a x-ray dichroism study of graphite surfaces [3,4] that addresses the origin and magnitude of ferromagnetism in metal-free carbon. We find that, in addition to carbon pi-states, also hydrogen-mediated electronic states exhibit a net magnetization with significant magnetic remanence at room temperature. The observed magnetism is restricted to the top ~10 nm of the sample where the actual magnetization reaches ~15 emu/g.

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