Low work function diamond and its tuneable electron affinity

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Wide-bandgap semiconductors are exploited in several technological fields such as electron emission devices, energy conversion, high-power high-temperature electronics, and electrocatalysis. Their electronic properties vary significantly depending on the functionalization of the surface. Here we show modulation of the electronic properties of diamond, one of the most interesting wide bandgap semiconductors for future energy applications, to show the tunability of its properties by modifying the surface termination.

Photoelectron spectroscopy was used to demonstrate the availability of a wide window of band bending, work function, and electron affinity. The band bending and work function were found to change by up to 360 meV and 2 eV, respectively, by varying the ratio of hydrogen to oxygen terminating the diamond surface. Because of the negative electron affinity of diamond, we were able to experimentally show the rigid shift of the whole band structure and explore the unoccupied conduction bands and determine a value for the effective electron mass in diamond of $0.2m_o$.

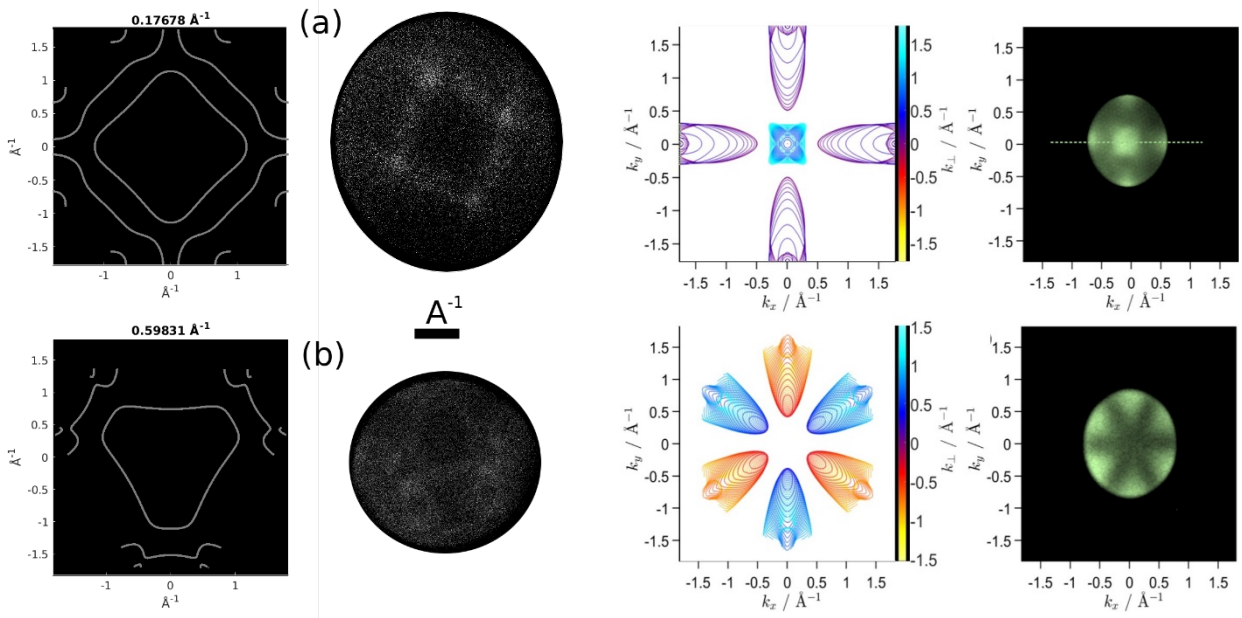

Figure 1: (Left) He II Full wave vector ARPES, (a) C(100) diamond, (b) C(111) diamond.

(Right) Conduction band mapping of (top) C(100) diamond, (bottom) C(111) diamond.