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#10-305 Thermal neutrons detectors using carbide heterostructures

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CADOR project (French ANR) aims at developing a new generation of neutrons detectors (NDs) based on the highly stable carbide heterostructure boron carbide (BxC)/silicon carbide (SiC). In such devices, the few µm thick BxC layer will serve as thermal neutrons converter for the 4H-SiC based semiconductor detector. The high amount of 10B close to SiC detector should enhance the detection efficiency, allowing considering on-line nuclear reactor monitoring. This should be favored by the high stability of these carbides which are expected to withstand high temperature operation, up to at least 500°C. Applications to low neutron flux measurements can be also considered for cleaning and dismantling operations, radioactive waste management and homeland security applications.

Three versions of BxC/SiC detector are targeted. In the simplest approach (Demo1), amorphous to polycrystalline films grown by PVD or CVD will be used as the neutron-converter layers on top of the 4H-SiC p-n junction. Thanks to the recent mastering (by LMI partner) of BxC epitaxial growth by CVD on 4H-SiC [1], a higher crystalline quality version of neutrons detector (Demo2) will be elaborated with an expected gain in terms of interface stability upon thermal stresses. A more innovating design to be investigated (Demo3) will take advantage of the intrinsic semiconducting properties of BxC material (which is known to be naturally p-type doped). It will involve a p-type epitaxial BxC film deposited on n- doped 4H-SiC in order to form the p-n junction.

CADOR multidisciplinary project goes from material elaboration to device fabrication and testing, completed by device simulation. Fabricating the three types of neutrons detectors requires important material developments and various characterizations for controlling the layers crystallinity, purity and intentional doping, as well as the different processing steps (dry etching, contacts⋯) for device fabrication. The fundamental electronic and optical properties of BxC material, which are largely unknown, are to be determined. Note that the chemical and mechanical stability of the BxC/SiC interface up to 500°C is of main concern for the application.

At ANIMMA conference will be presented the advancement state of CADOR project, focusing on Demo1 device. This will include not only device simulation (for both optimization of the designs and performance prediction) but also BxC material development (thickness, roughness, strain, chemical composition, dry etching⋯).

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