3C- SiC nanowires and layers grown on Si: attractive material for biosensor applications

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Nonotechnology is becoming an interesting field of research for biomolecular and medical diagnostics. The repeated screening is of crucial importance in the diagnosis of cancer and malignant tumours, since the pathologies at the early stages can be treated with the highest success probability.

Many innovative approaches are emerging for the overcoming of this challenge, such as nanostructured surfaces for the enhancement of proteomic analysis, nanowires (NW) as biologically gated transistor, transductor for molecular binding events into real-time electrical signals and cantilevers for mechanical-based detection of biomolecules

The interface of a biological system with tailored made detectors at the molecular scale opens the possibility to develop a entirely new class of devices and personal monitoring systems.

The materials selected for these nanostructures must be biocompatible to ensure they are nontoxic and non-invasive for the organism, and must be capable to work in a very harsh environment.

Silicon carbide (SiC) is mechanically robust, chemically inert, non toxic and biocompatible, so is a good material for biomedical purpose and for biosensor and bioelectronic applications.

Several medical tools already uses SiC as bio-compatible coating, such as biomedical needles used in open heart surgery monitoring or temperature sensors based on bulk SiC. Nanosensors for ultrasensitive detection of proteins down to individual virus particles are also realised.

Covalent bonding between specific molecules and stable interfaces are required for the realisation of biosensors based on molecular recognition, and since it was also demonstrated that SiC surfaces can be functionalized in order to react to specific biomolecules, this material is an optimal candidate for these kind of medical applications.

Here we report a study on properties β–SiC-NWs and SiC layers deposited on silicon. Nanowires has been prepared with carbon oxide and nickel as catalytic element in nitrogen or argon atmosphere at the temperature between 1050 to 1100°C.

Nanowires has been characterised by X-ray diffraction (XRD), by Scanning Electron Microscopy (SEM), Cathodoluminescence (CL) and by means Transmission Electron Microscopy (TEM).

XRD patterns confirmed the characteristic peaks at 2θ =35.6° (111), 41.4° (200), 59.9° (220), 75.5° (222) indexed as β–SiC.

The room temperature CL spectrum revealed a broad peak centred at about 2.34 eV, related to the indirect band gap transition in β-SiC, and an intense blue band at about 2.68 eV.

TEM images showed the crystalline core, having a <111> growth axis, sheathed by amorphous oxide. Typical SiC planar defects were present mainly on (111) planes, either stacking faults or rotational twins. Selected area electron diffraction from single NWs indicated the main phase as β-SiC.

The SiC thin films were deposited on 2'' 001 Si wafers by means of VPE technique in a home made reactor with induction heating. A growth procedure at atmospheric pressure involving several steps (thermal etching, carburisation, epitaxial growth) was implemented. The precursor of choice were dilute SiH_4 and C_3H_8 while H_2 was used as carrier gas.

The layers have been characterised by XRD, SEM, AFM.

X-Ray diffraction evidences SiC(001) film is well oriented whit respect to the substrate having a narrow peak. SEM and AFM observations indicate a smooth film with good morphology.