β-SiC NWs grown on patterned and MEMS silicon substrates

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One-dimensional materials have become an attractive field of research due to their potential applications in physics, development of nanodevices and sensors. Nanowires (NW) are particularly interesting for their enhanced properties with respect to the bulk materials. Moreover the dimension of these nanostructures is comparable to those of the biological and chemical species being sensed.

Silicon carbide in the form of NW is a material of great technological interest because of well known properties such as wide band gap, high temperature stability, extreme hardness, chemical inertness, biocompatibility.

The deposition and the use of nano-patterned substrates as template in physics and biophysics is a first step to study adhesion of living cells and cell culture for biocompatibility and sensing.

The fabrication of Micro Electrical Mechanics Systems (MEMS) with different geometries and patterned substrates for selective deposition can help to study the possibility to realize devices with higher performances. Here we present the growth of cubic silicon carbide nanowires on patterned silicon substrates and on silicon MEMS. Two type of substrates were used in these experiments:

- patterned silicon substrates with peculiar geometries obtained by conventional photolithographic techniques

- different MEMS structures such as cantilevers, bridges and springs realized on (001) Silicon On Insulator (SOI) wafer

On both, a nickel thin film of nominal 2 nm thickness was deposited using an e-beam system, because it was found that nickel plays an important role as a catalyst for the NW growth.

After a preheating at 1100°C for two minutes at atmospheric pressure to form little droplets of metal catalyst on the substrate surfaces the nanowires growth was obtained with propane and silane diluted 3% in hydrogen at the temperature of 1100°C, with a growth time of 5-10 minutes.

The as grown nanowires were first characterized by X-ray powder diffraction to confirm the cubic structure; the shape and the growth habit of the 3C-SiC NW were studied using a Scanning Electron Microscope (SEM) and a 200 kV Transmission Electron Microscope (TEM).

Two examples of as grown nanowires are shown in figure 1 and 2: it is possible to see that nanowires, several tens of μm long and with an average diameter of about 100nm, are well distributed on the surface previously covered with catalyst.

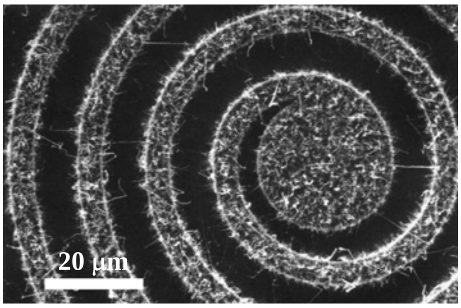

Fig 1: SEM micrograph of 3C-SiC NW obtained on a Si spring

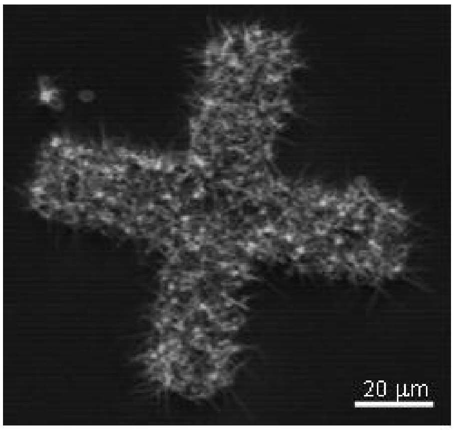

Fig 2: selective NW growth in a cross-shaped area of the Si substrate.

The cubic structure of the grown nanowires has been confirmed by using X-ray diffraction. XRD patterns shown the characteristic peaks $2\Theta = 41.4°$ (200), typical for cubic SiC.
The electron diffraction patterns and the high-resolution TEM data confirmed the NW are predominantly 3C polytype with (111) growth axis, but stacking defects occur on (111) planes. Z-contrast and EDX analyses showed a Ni-containing particle on top of the NW, indicating a metal-catalysed VLS growth mechanism.