Wide band gap materials

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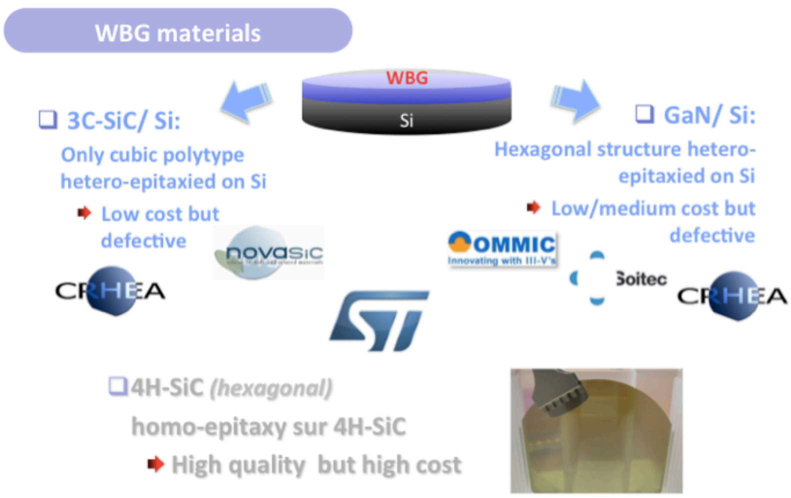
Wide Band Gap (WBG) material (SiC, GaN) is an ideal candidates for power applications, due to their properties such as : **high saturation velocity**, **high critical electric field**.

Many labs are currently working on the WBG materials in France & Europe. Since the beginning of the activity in 2004, our group is working on process and characterization development with a clear positioning: **WBG materials and devices at LOW COST.**



Gallium Nitride (GaN)

Gallium Nitride(GaN) is an attractive semiconductor. During the last few years, it has found applications in optoelectronics devices, laser diodes (LDs), blue to green light-emitting diodes (LEDs) or high electron mobility transistors (HEMTs). More recently, electronic devices based on GaN technology for high power and high temperature functioning have been investigated. Due to its**wide energy gap**and**high electron-saturated drift velocity**, GaN based devices are good candidates for**power devices with higher performances**in terms of current density or reverse breakdown voltage for example. In the context of the National G2REC project (OSEO), Tours 2015 project and national labex GaNex, GREMAN is working to achieve a**Schottky diode**able to reach 600 and 1200V in a reverse mode with low leakage current on 6 and 8 inches GaN/Si wafers.

Silicon carbide (SiC)

Due to its excellent electrical, mechanical and chemical properties, silicon carbide is an excellent candidate to achieve **electronic devices**. For this thematic, a 4H-SiC Junction Barrier Schottky diode has been preferred as a vehicle test. The development of such an electronic component requires to control technological issues like doping, ohmic contacts, Schottky contacts, passivation...

Since few years, our group has also developed an expertise for the characterization of doping in semi-conductor materials at the nano-scale with the electrical modes based on Atomic Force Microscopy. For example, this expertise has led to the demonstration of the**electrical activity of extended defects in 3C-SiC**.

According to the electrical activity of the extended defects evidenced by our group in 3C-SiC, electrical applications seem to be a challenge with 3C-SiC. However, for **Micro-Electro-Mechanical-Systems** (MEMS) applications, due to its unique mechanical and physical properties, 3C-SiC is favored according to its capability to be grown on cheap and large diameter silicon substrates.

In last years, thanks to a close collaboration with CRHEA-CNRS, we succeeded to achieve, for the first time, a 3C-SiC micro-structure on a 3C-SiC pseudo-substrate. This result was attained by means of surface **micromachining** and using a silicon film as a sacrificial layer. Initially, the surface of the membrane was rough and faceted but recently, thanks to an optimization of the growth, we demonstrated that smooth 3C-SiC membranes on 3C-SiC pseudo-substrates can be « easily » obtained.

Considering the properties of this material, the perspectives of such a structure **could** be massive, for example in medical field where the silicon carbide biocompatibility is a huge advantage. The SiC thermal properties combined with its chemical inertia could be also great benefits to design new MEMS devices, which could be subjected to harsh environments. The efforts developed now are then devoted to address original applications based on this structure.

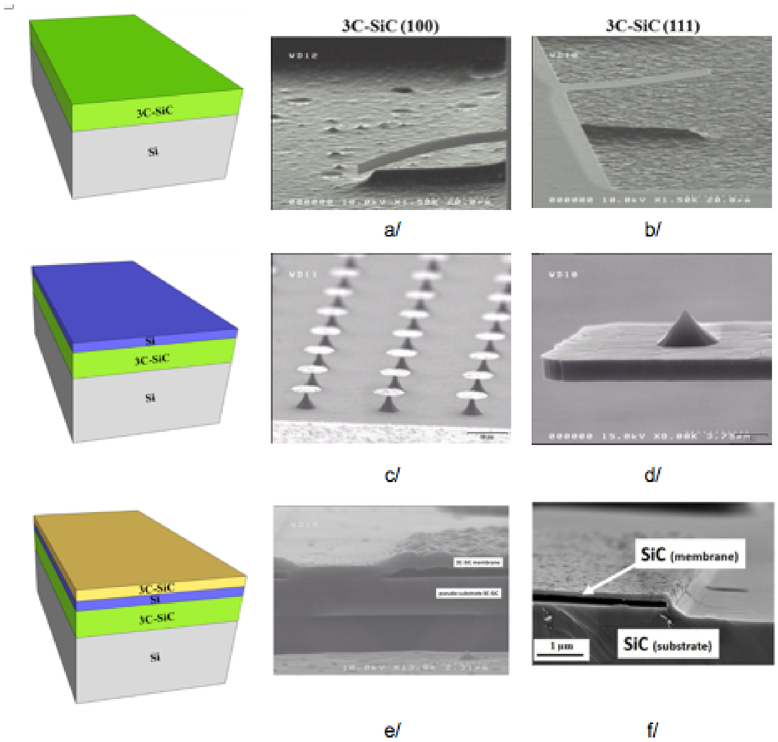


Figure : SEM pictures of 3C-SiC cantilevers elaborated on (a) 100-oriented material, (b) 111-oriented material, (c) monocrystalline Si tip array elaborated by ICP plasma etching and (d) the resulting final tip on a 3C-SiC cantilever, (e) first 3C-SiC micro-structure with a 3C-SiC membrane presenting a rough and faceted surface and (f) optimized 3C-SiC micro-structure with a smooth 3C-SiC membrane.

For each line, the schematic illustration on the left corresponds to the heterostructure used to elaborate the devices presented on the SEM images of the right.