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## Bio-inert diamond surfaces as novel candidates for bio-electronics applications

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Bioelectronics is a rapidly progressing field at the junction of physics and biochemistry. Diamond shows attractive properties due to its remarkable bioinertness. It is a promising candidate for bio-electronic devices as it shows good electronic and chemical properties, can be grown single-, poly- or nanocrystalline, either by homo-epitaxy or by hetero-epitaxy on a variety of substrates. Further, the high acoustic velocity makes diamond surface layers good candidates for wave confinement for SAW detection devices. Similarly, its high Young's modulus makes it attractive for bio sensing applications based on cantilever structures. Further to the high bioinertness of diamond, the high electrochemical stability, and optical transparency finally also provide diamond with high interests for electrochemical or optical biodetection.

Conductive diamond electrodes can be obtained using Boron doping and are now finding increasing use in electrochemistry, as a result of their stability and reproducibility, which is effectively coupled with a wide operating potential window, low background currents and a resistance to electrode fouling. Although much of the original work has tended to focus on bare, macroscopic electrodes manufactured from polycrystalline diamond, interest has begun to focus on the use of different forms of diamond, the development of ultramicroelectrodes, and the use of surface functionalisation methods. To attach biomolecules to diamond, photochemical surface modifications can be applied. Here we analyse the functionalisation of boron-doped diamond surface electrodes. For example, biotin was attached to diamond surfaces and characterized using X-ray Photoelectron Spectroscopy (XPS), Atomic Force Microscopy (AFM) as well as fluorescence analysis. XPS analysis and spectrum interpolation led to the identification of the species on the surface in order to highlight the surface coverage and attachment of the grafted film. AFM measurements highlighted the non-mononuclear aspects of the diazonium electrografting. Such a study can serve as a demonstrator for the further diamond modification with more complex recognition structures such as proteins or enzymes in the view of bio-sensor developments.

### **Contact and presenting author**

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#### **Professional Experience**

**Since March 1994** : Research Assistant and Research Manager

Currently head of the Detector Technology laboratory at the French Atomic Energy Commissariat (CEA) in Saclay

**Management and Development of a research activity : new electronic materials development, such as synthetic diamond, for specific applications and radiation detection.**

- Material Growth, Device Fabrication, Process Optimisation
- Optimisation of the Elaboration conditions
- Material Characterisation device developments for specific industrial applications (

## Training

2007 : HDR : February 2007 : Le diamant synthétique appliqué à la détection : De la compréhension du rôle des défauts à l'optimisation des performances.

1994 : Ph.D. in Electronic Materials at the University College London (United Kingdom) (*Laser Processing and surface Science* laboratory) : New applications of excimer lamps to the photo-CVD of dielectric thin films.

1990 : DEA (French Master) on Integrated electronic devices (INSA Lyon)

1990 : French Engineering Diploma from the *National Institute of Applied Sciences* Lyon (physics, electronics,  $\mu$ -electronics)

**Scientific Communications** - Over 150 contributions in scientific journals, Attending as author to over 70 meetings and international conferences. 17 times invited to international conferences

Member of several diamond conference committees and editorial scientific committees

## Selection of recent articles

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- J.C. Arnault, L. Intiso, S. Saada, S. Delclos, and P. Bergonzo, R. Polini, Effect of 3C-SiC(100) initial surface stoichiometry on bias enhanced diamond nucleation, Applied Physics Letters, In press
- J.C. Arnault, S. Saada, S. Delclos, L. Intiso, N. Tranchant, R. Polini, Ph. Bergonzo, In situ study of the initial stages of diamond deposition on 3C-SiC(100) surfaces: towards the mechanisms of diamond nucleation, Diamond and Related Materials, in press
- Hassen Hamrita, Dominique Tromson, Caroline Descamps, Christine Mer, Milos Nesladek, P. Bergonzo, Improving Diamond Device Performances for Pulsed Mode Detection, A paraître au MRS Symposium Proceedings Diamond Electronics, Boston, 2006 (Editors P. Bergonzo, R.B. Jackman, C.E. Nebel, R.Gat)
- P. Bergonzo, D. Tromson and C. Mer - CVD diamond-based semi-transparent beamposition monitors for synchrotron beamlines: preliminary studies and device developments at CEA/Saclay, Journal of Synchrotron Radiation, Vol. 13 (2) 151-158 (2006)
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- P. Bergonzo, A. Brambilla, D. Tromson, C. Mer, B. Guizard, R. D. Marshall & F. Foulon. CVD diamond for nuclear detection applications. Nuclear Instruments & Methods in Physics Research, Section A Accelerators, Spectrometers, Detectors and Associated Equipment 476, 694-700 (2002).
- K. Bobrov, G. Comtet, G. Dujardin, L. Hellner, P. Bergonzo & C. Mer. Surface electronic states of the partially hydrogenated diamond C(100)-(2\*1):H surface. Physical Review B Condensed Matter and Materials Physics 63, 1-9 (2001).