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Diamond microelectrodes: Theory, technology and biomedical applications

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Abstract

Among all known materials, diamond is unsurpassed in terms of hardness, Young modulus and fracture strength, thermal conductivity, breakdown field and carrier mobility. Its chemical stability and biocompatibility are excellent, and its optical transparency ranges from ~250 nm to tens of microns.

Having a bandgap of ~5.5 eV, diamond is a very good electrical insulator, but when doped with boron its conductivity can be tailored in a wide range up to a quasi-metallic behavior.

Therefore, considering all properties mentioned above, diamond is a very interesting material for a variety of applications.

Electrochemical biochips fabricated using thin-films of synthetic boron-doped diamond (BDD) grown on insulating substrates are primarily targeted to amperometric detection of redox biomolecules, showing excellent sensitivity, very low noise, fast response and long-term reliability. Besides that, BDD-biochips have also demonstrated good results by the detection of bioelectrical and chemical potentials. Simultaneous detection of fluorescent signals during bioelectrochemical recordings was also demonstrated.

In summary, this lecture will first recall some basic concepts of electrochemistry, then the focus will move to diamond microfabrication technology including examples of devices fabricated at Ulm University and finally a few applications will be described.

The speaker

Education

1971 – 1976: High School for electronics and nuclear energy applications

1976 – 1984: Study of Physics at University "La Sapienza", Rome (Italy)

Professional Experience

1983 - 1984: Thesis on "Integration of Superconducting Magnetometers for Biomagnetism"

1986 - 1989: Researcher at the "Physikalische Technische Bundesanstalt" in Berlin (Germany)

1989 - 1996: Researcher at CNR - IESS in Rome

1996 to present: Senior Scientist at Ulm University, Ulm, Germany.

Teaching and Tutoring

1991 to 2000: Lecturer on "Biomagnetism", "Analog and Digital Electronics" and "Biomedical Instrumentation" at several national and international summer schools and workshops

2008 to present: Lecturer for the course "Biosensors and Biochips", for Master students

2010 to present: Lecturer for the course "Semiconductor Sensors", for Master students