## Institute

INFN Florence – Department of Energetics University of Florence

## Head of the research group

Mara Bruzzi

## Area of interest

This group joins together experience and expertise of solid state matter, nuclear and high energy physics. The research activity is mainly focussed on advanced semiconductor materials and devices for applications in the fields of high energy, nuclear and medical physics. This group has developed in the past high quality experimental systems for material synthesis and semiconductor characterisation. In particular it gained relevant expertise in the study of defects in the semiconductor material bulk, by means of different and conceptually original spectroscopic techniques (TSC, DLTS, PICTS), which have been applied in the study of the lattice disorder induced by radiation in semiconductor detectors, especially Si, polycrystalline diamond and SiC. The activity of this group in this field of research has always given and is presently giving a significant contribution to the international scientific community.
Detector efficiency characterisation ( charge collection efficiency, dosimetric sensitivity, charge collection distance ) are also in the area of interest of this group, which is constantly collaborating with the CMS community in the development of Si microstrip detectors, and with the medical physics community in the development of advanced semiconductor material for clinical dosimetry ( Si, diamond, SiC ). A relevant experience of this group concerns the synthesis of semiconductor materials by Chemical Vapour Deposition (CVD). In particular a proprietary pulsed glow discharge CVD reactor has been developed with the aim to produce CVD diamond films for radiation detection.

## Facilities

*Material Characterisation*

μ-Raman
SEM
Plasma emission imaging spectrometry in the UV-VIS range

*Semiconductor Device Characterisation*

| | |
|---|---|
| I-V | Keithley 6517A, Keithley 237 |
| C-V | HP4284A, $\Delta f$ = 200Hz-1MHz |
| I-T, C-T | P ~ $10^{-7}$ mbar , $\Delta T$ = 4.2-700K |
| Four Point Probe resistivity | $\Delta T$ = 12-350K, Keithley system |
| Hall Effect | $\Delta T$ = 12-350K, Keithley system |
| Photo-conductivity | $\lambda$ = 200-1000nm, $\Delta\lambda$ = 5nm $\Delta T$ = 77-500K, P ~ $10^{-5}$ mbar |

*Defect Characterisation*

Thermally Stimulated Currents
$\Delta T$ = 4.2-700K Current resolution = 0.1pA
Priming sources: LED, Pulsed Xenon Lamp, 20MeV electron from LINAC, $\gamma$-$Co^{60}$, $Sr^{90}$

Capacitance Deep Level Transient Spectroscopy
$\Delta T$ = 20-350K
Priming sources: LED, Pulsed Xenon Lamp for UV range

Photo Induced Current Transient Spectroscopy
$\Delta T$ = 20-350K
Priming sources: LED, Pulsed Xenon Lamp for UV range

Thermoluminescence
$\Delta T$ = 300-700K
Priming sources: LED, Pulsed Xenon Lamp, 20MeV electron from LINAC, $\gamma$-$^{60}$Co, $^{90}$Sr

*Material synthesis*

Glow Discharge Chemical Vapour Deposition reactor for the synthesis of polycrystalline diamond

*Thermal Treatments*

Annealing up to 700K under controlled atmosphere conditions in vacuum and in different gases ( $H_2$, $N_2$, $O_2$ , He)
Hydrogen plasma etching up to 1500K

*Detector Efficiency Characterisation*

Dosimetric characterisation system with a linear accelerator Philips SL25 for 6-25MeV electrons, 6-25MV photons
Charge collection efficiency measurement with $^{90}Sr$ and $^{241}Am$ sources ( in progress )

*Manpower availability*

The group is composed by the following staff:

| | Position | Man/month per year |
|---|---|---|
| M. Bruzzi | Associate Professor of Physics | 10 |
| E.Borchi | Full Professor of Physics | 2 |
| M. Bucciolini | Full Professor of Physics | 4 |
| S. Sciortino | Assistant Professor of Physics | 10 |
| D. Menichelli | Post-Doc fellowship | 10 |
| A. Baldi | Technician | 6 |
| S. Lagomarsino | PhD student | 10 |
| S. Miglio | PhD student | 6 |
| S. Pini | Master student in medical physics | 10 |

**Selected Publications of the Group**


[1] U.Biggeri, E.Borchi, M.Bruzzi, Z.Li and S.Lazanu, Studies of Deep levels in High Resistivity Silicon Detectors Irradiated by High fluence fast neutrons using a Thermally Stimulated Spectrometer, **IEEE Transaction Nuclear Sciences**, vol.41, 4, (1994), p.964-970.

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[10] T.Bacci, E.Borchi, M.Bruzzi, M.Santoro, S.Sciortino, Correlation between material properties and leakage currents in CVD diamond films deposited by DC plasma glow discharge, **Material Science& Engineering B**, vol.B47 (1997), 54-63.

[11] T.Bacci, E.Borchi, M.Bruzzi, M.Santoro, S.Sciortino, Change in Surface Morphology of diamond films deposited by DC plasma glow discharge CVD, **Material Science & Engineering B**, vol. B48 (1997) 268-278.

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[13] U.Biggeri, E.Borchi, M.Bruzzi, Z.Li, E.Verbitskaja, Study of electrical properties of high- and medium- resistivity silicon detectors irradiated with very high neutron fluence, **Nuclear Instruments & Methods A**, vol. A409, (1998), 176-179.

[14] M.Bruzzi, E.Catacchini, R.D'Alessandro, G.Parrini, Heavily irradiated double-sided wedge silicon microstrip detector, **Nuclear Instruments & Methods A**, vol. A409 (1998), 132-134.

[15] T.Bacci, E.Borchi, M.Bruzzi , M.Santoro, S.Sciortino, Structural characterization and transport properties of diamond films prepared by DC plasma glow discharge CVD, **Inorganic Materials**, vol. 34, 4, (1998), 321-331.

[16] E.Borchi, M.Bruzzi, S.Pirollo, S.Sciortino, High-Temperature Thermally Stimulated Currents analysis of CVD Diamond films, **Solid-State-Electronics**, vol. 42, 4, (1998), 674-676.

[17] E.Borchi, M.Bruzzi, C.Leroy, S.Pirollo, S.Sciortino, Charge collection and noise analysis of heavily irradiated silicon detectors, **IEEE Transasction-Nuclear-Science**, vol. 45, 2, (1998), 141-145.

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