

Rossella Brunetti

Università degli Studi di Modena e Reggio Emilia
Dipartimento di Scienze Fisiche, Informatiche e Matematiche

Academic Discipline:
PHYS-04/A Fisica teorica della materia, modelli, metodi matematici e applicazioni

Short Curriculum

Born in Modena on November 11, 1957

1975 *Classical High School Diploma (score 60/60)*

1981 *Master Degree in Physics from the Physics Department of the University of Modena. Dissertation focused on Electron Transport Theory in Silicon, (score 110/110 cum laude).*

1982 Tutor and Manager *of the Computer Science School of the University of Modena.*

1983 Winner of the Young Researcher's Prize *of the Italian Physical Society*

1983 *Winner of a PhD grant of the Modena-Parma Doctoral School in Physics (just established in Italy) .*

1987 PhD in Physics. *Dissertation focused on: "Monte Carlo solution of the Liouville-von Neumann equation for Quantum Transport in Semiconductors".*

1987-1990 Winner of a research grant *sponsored by SGS-Thomson and by the National Research Council. Research topic: Materials and devices for solid-state electronics.*

1990-2002 *Research and teaching assistant at the Physics Department of the University of Modena .*

From 2002 *Associate Professor in Physics at the Department of Physics, Informatics and Mathematics of the University of Modena and Reggio Emilia.*

Scientific Activity

The research activity, carried on in collaboration with many research groups in Europe and overseas, started from a theoretical and computational analysis of charge transport and noise properties of bulk elemental semiconductors and, then, moved on towards the analysis of electron-transport features of semiconductor structures and devices in semiclassical and quantum conditions. In particular her scientific activity included the formulation of charge –transport

approaches suitable to be included into device- simulation tools, with the purpose of improving the adopted physical model and increasing their predictive capability. A collaboration with the device-simulation group led by Prof. Massimo Rudan and Prof. Giorgio Baccarani at the Electrical engineering Department of the University of Bologna has been established on the above mentioned topics and it has been maintained through the following years until the present time. Furthermore quantum transport problems in mesoscopic structures and low-dimensional systems have been tackled by RB. In particular, she studied electronic coherent transport properties in systems of coupled quantum wires in view of possible applications to quantum computation devices. The Wigner-function approach to quantum transport has been used by RB to deal with the problem of dissipative quantum transport and applied to low-dimensional semiconductor structures. RB's simulation skills range on a variety of numerical techniques (mainly the Monte Carlo approach and, more recently, Molecular Dynamics) which have been applied to obtain results for many different semiconductor systems and beyond. It is worth mentioning an innovative pioneer activity carried out by RB which encompassed the formulation of a theoretical and simulative model approach for the analysis of single-channel ion current and noise based on a coupled Molecular Dynamics and Monte Carlo approaches. The research activity has been carried on in collaboration with SISSA, Trieste and the University of Cagliari, for the case of potassium ions permeating the KcsA channel, but the method can be extended to the analysis of other channels, provided that the atomic structure of the channel protein is available from diffractometric analyses.

In more recent years (from 2010) RB focused her research interests on transport properties of chalcogenide materials in view of their application in the field of memory devices. This research has been partly supported by INTEL-USA. A microscopic model based on the Hydrodynamic approach has been formulated and improved through the years to describe the conduction features of Ovonic and Phase-Change materials. The theoretical approach has been numerically implemented in a simulation tool which is suitable to be included into commercial device-simulation approaches. The first implementation dealt with GST, which is by far the most interesting chalcogenide alloy for technological applications. Then results have been collected for other chalcogenides (AIST, and, more recently ZnTe) both for steady-state and transient conditions in non-homogeneous electric-field conditions, also including the effects of the external circuitry on the electrical response of a nanometer chalcogenide-based device. Excellent comparison with available experimental results have been obtained so far. Collaborations on specific topics have been established with Prof. Pop (Stanford, USA), Prof. Ielmini (Politecnico Milano) e the experimental groups of Dr. Manivannan () and Prof. Hwang (). The most recent development of the above-described research include the use of graphene as contacting material, exploiting the intrinsic low-dimensionality of this material and its peculiar physical properties to pursue the design of self-heating devices which can be assembled into planar device arrays. To this end a collaboration with the CNR-IMM Department located in Bologna and Catania has been established.

RB has been member of the 'International Scientific Committee of the International Conference "Simulation of Semiconductor Devices and Processes (SISPAD)" in the years 1998, 2000, and 2004.

She is presently member of the Referee Board of a number of International Scientific Magazines (Physical Review, Physical Review Letters, Journal of Applied Physics, IEEE Trans. El. Devices, Journal of Microelectronics, J. Phys. D.).

She has been serving as member of the Program Committee of the "XIII Conference on Nonequilibrium Carrier Dynamics in Semiconductors", Modena 2003 and Editor of the Proceedings of the same Conference.

She has been Member of the International Advisory Committee of the "Conference on Nonequilibrium Carrier Dynamics in Semiconductors", from 2004. She is member of the Program

Committee of the 22th edition of the International Workshop on Computational Nanotechnologies (IWCN), Barcelona June 2023.

She has been Principal Investigator of two Research Contracts with INTEL (USA):

“*Microscopic Analysis of the Structural and Transport Features affecting the Electrical Threshold of Amorphous GST*”, years 2007-2009 e 2009-2011, and “*First-principle and macroscopic modelling of transport in nanometric PCM devices to establish ultimate scaling limits* ”, years 2011-2014.

Present national and international collaborations

ITALIA

Prof. Ing. M. Rudan, Prof. Elena Gnani, Università di Bologna

Dott. D. Ielmini, Politecnico di Milano

Dott.ssa Rita Rizzoli, CNR Bologna.

Dott. Giuseppe D’Arrigo, CNR Catania

Dott. Ing. Enrico Piccinini, Applied Material Italia (Reggio Emilia)

INDIA Prof. Anbarasu Manivannan, Indian Institute of Technology Madras, India.

Outreach activities

Since 2004 RB is the scientific coordinator of the multidisciplinary activity “La Curiosità fa lo Scienziato”, sponsored by the University of Modena and Reggio Emilia, devoted to students and citizens. Every year hands-on experiments, posters and interactive activities are planned by a scientific team on the basis of a fixed multidisciplinary scientific topic. The lab is visited by hundreds of people every year.

Presently RB is the coordinator of a multidisciplinary project aimed at restoring the collection of historic scientific instruments of the University of Modena and Reggio Emilia (1750- 1960). In 2025 RB will organize the exhibition: “Modenese Treasures rediscovered” which will take place in Modena from october to december 2025, being it included in the initiatives celebrating the 850 years of the University in Modena and Reggio Emilia.