Keynote speaker:

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Title of the presentation:

2D Materials: fabrication, properties, and applications in electronic and optoelectronic devices

Short CV:

Antonio DI BARTOLOMEO is a full professor of Experimental Condensed Matter Physics at the University of Salerno, Italy, where he teaches semiconductor device physics and nanoelectronics. He is an IEEE senior member and and IEEE NTC Distinguished Lecturer.

His present research interests include optical and electrical properties of nanostructured materials such as carbon nanotubes, graphene, and 2D materials, van der Waals heterostructures and Schottky junctions, field-effect transistors, non-volatile memories, solar cells, photodetectors, field emission devices, and supercapacitors.

He has been an invited speaker in over 100 international conferences and has authored about 200 publications in peer-reviewed journals, two physics textbooks, and two patents. He is serving as the editor-in-chief of IOP Nano Express and IET Micro & Nano Letters, the section editor-in-chief of MDPI Nanomaterials and is an editorial board member of several journals.

Abstract:

Two-dimensional materials hold great promise for future nanoelectronics. Their atomic thickness enables highly scaled field-effect transistors with reduced short-channel effects and relatively high carrier mobility.

In this presentation, the electrical and optical properties of 2D transition metal dichalcogenides (TMDs such as MoS_2, WSe_2, $ReSe_2$, $PtSe_2$, and $PdSe_2$), GeAs, and black phosphorus are discussed.

The intrinsic electrical transport properties of 2D materials are commonly investigated using back-gated field-effect transistors, due to the low density of process-induced defects and the easy fabrication. Electrical transport, modulation of the conductivity by a back-gate, effect of electron irradiation, environmental pressure and surface adsorbates, and photoresponse are investigated in TMD nanosheets obtained by either mechanical exfoliation or chemical vapor deposition on SiO_2/Si substrates.

It is shown that the contact resistance can be tuned by electron irradiation, which reduces the Schottky barrier and improves the 2D material/metal contact. It is demonstrated that adsorbates can change the polarity of the charge carriers and enhance the hysteresis in the transfer characteristics of TMD-based field-effect transistors. It is reported that several 2D materials exhibit strong photoresponse due to their direct bandgap and density of states that favour the interaction with light. Time-resolved photocurrent measurements demonstrate that many 2D based devices exhibit slow or persistent photoresponse that is attributed to intrinsic or extrinsic trap states, photobolometric effect and desorption of adsorbates. It is highlighted how positive and negative photoconductivity can coexist in the same 2D-based device, the dominance of one type over the other being controlled by O_2 and H_2O adsorbates.

The strong dependence of the channel conductance on electrical stress, air pressure, gas type, and light make 2D materials-based devices suitable for memory, gas, and light sensing applications.

Finally, as the tunable conductivity and the sharp-edge geometry facilitate the extraction of electrons under the application of an electric field, it is proved that several 2D materials are also effective field emitters and that their emission current can be modulated by a back-gate.