ECE Distinguished Seminar Series

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1:30 pm, 260 Dreese Laboratories

Prof. Michael Shur

Terahertz Plasmonic Devices

Abstract: Numerous applications of terahertz (THz) technology range from THz sensing and imaging to THz communications and Beyond 5G applications. These applications require efficient, small, and inexpensive THz detectors and sources. This need could be met by THz electronics. Two-terminal semiconductor devices are capable of operating at the THz range, with the highest frequency achieved using Schottky diode frequency multipliers (reaching a few THz). High speed three terminal electronic devices (FETs and HBTs) are approaching the THz range (with cutoff frequencies and maximum frequencies of operation above 1 THz and close to 0.5 GHz for InGaAs and Si technologies, respectively. A new approach called plasma wave electronics recently demonstrated terahertz emission and detection in GaAs-based and GaN-based HEMTs, and in Si MOS, SOI, FINFETs and FET arrays, including the resonant THz detection. Terahertz Plasmonic Devices have the potential to become a dominant THz electronics technology. The FET feature sizes have shrunk to the point, where ballistic (collisionless) mode of electron transport is becoming dominant. In the ballistic regime, the device physics is completely different. For example, the effective electron mobility becomes proportional to the device feature size. THz radiation excites the waves of the electron density (i.e. plasma waves) in transistor channels. These waves have characteristic frequencies in the THz range even for devices with feature sizes exceeding a few hundred nanometers. Rectification of plasma waves can be used for detecting THz radiation and for imaging and in-situ testing of transistor structures. Since propagation of plasma waves is strongly affected by the field distribution in the device channel, plasmonic devices exposed to THz radiation could resolve nanometer feature sizes. In ballistic devices, plasma waves become unstable and cause THz emission. Recently proposed plasmonic boom devices operate under the ballistic transport conditions and use the spatially modulated electron drift velocity exceeding the plasma velocity and causing a "plasmonic boom" instability. "The terahertz (THz) sources using such nanostructures have promise of achieving THz powers up to 100 mW or higher. The plasmonic THz detectors have reached Noise Equivalent Powers down to $pW/Hz^{1/2}$ range. The plasmonic electronics technology might become a dominant THz electronics technology.

Bio: Michael Shur is Patricia W. and C. Sheldon Roberts Professor at RPI. He received MSEE Degree (with honors) from St. Petersburg Electrotechnical Institute, and PhD. and Dr. Sc. Degrees from A. F. Ioffe Institute. He is Fellow of the US National Academy of Inventors, IEEE, APS, OSA, SPIE, ECS, IET, MRS, WIF, AAAS, and Member of Eta Kappa Nu, Tau Beta Pi, ASEE, MTT, Sigma Xi, and Humboldt Society. Professor Shur served as Member-at-Large of the IEEE EDS Board of Governors, Vice-President of IEEE Sensors Council, Chair of the URSI US Commission D, and Associate Editor of IEEE ED Transactions. He is Editor-in-Chief of IJHSES and book series on Electronics and Systems, Member of the Editorial Board of physica status solidi, the Honorary Board of Solid State Electronics, and JSTS International Advisory Committee. He is Foreign Member of the Lithuanian Academy of Sciences, and Distinguished Lecturer of IEEE EDS and IEEE Sensors Council. Dr. Shur is a co-founder and a former Vice-President of Sensor Electronics Technology, Inc. He received Tibbetts Award for Technology Commercialization, St. Petersburg Technical University and University of Vilnius Honorary Doctorates, IEEE Sensors Council Technical Achievement Award, IEEE Donald Fink Best Paper Award, IEEE Kirchmayer Award, Gold Medal of the Russian Education Ministry, van der Ziel Award, Senior Humboldt Research Award, Pioneer Award, RPI Engineering Research and Outstanding Engineering Professor Award, Wiley Award, and several Best Paper Awards.

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