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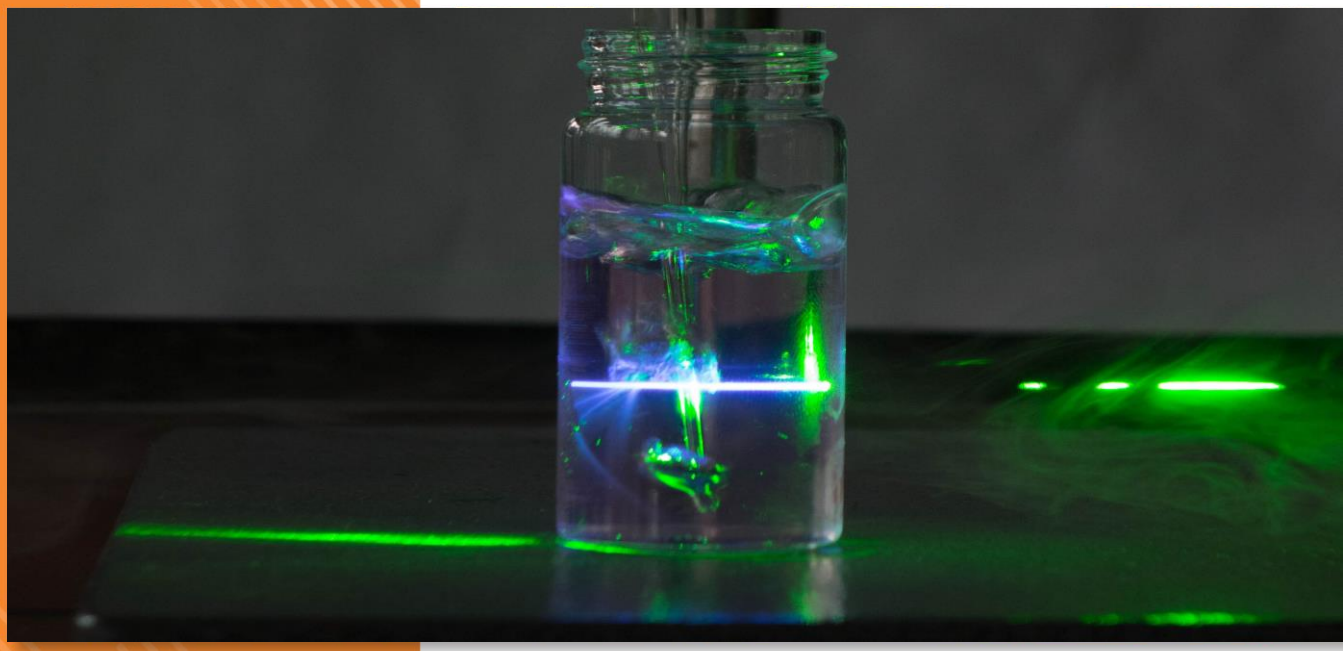

Designing planar architectures and materials for high-frequency electronic devices

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Considering the increased popularity of the Internet of Things (IoT) and Wireless Sensor Networks (WSN), RF energy harvesting (WEH) is in demand. Because it will be able to recharge and even, in some cases, replace batteries. That would make the life span of these devices longer, easier to maintain and reduce power wastage. It will also facilitate lightweight wearable devices as a reality. The electromagnetic spectrum in 30GHz~3THz range is attracting attention for potential applications in hidden weapon detection, aviation assistance, and spectroscopy for detecting harmful molecules and breath analyses, short-range radar, secured high-speed data transmission and more. A critical component for the electronic circuitry for these applications is a detector, i.e., a rectifier. A sufficiently large communication range is essential for WEH applications. Since the path loss of an EM-far-field strength is inversely proportional to the square of the distance, the threshold voltage of the rectifiers must be as small as possible. A Schottky barrier diode (SBD) is the best choice for this.

I will discuss overview of my group research in the recent years. In the first part, I will introduce the important criteria to achieve higher cut-off frequencies in SBDs and its figures-of-merits. Secondly, I will showcase efforts of implementing nonlinearity in the in-plane charge transport of monolayer graphene and its application as a high-frequency power detector. Thirdly, I will extend similar concept with an example of molecular adhesion lithography fabricated planar asymmetric nanogap electrodes with channel length of ~15 nm and its implications to realize above 100 GHz Schottky barrier diodes. I will show how this design is suitable for various materials viz. ZnO, IGZO, and DNTT. The aim is to achieve a threshold voltage of less than 0.15 V. When these SBDs are operated at zero bias, they should be able to rectify the RF signals > 300 GHz with DC output power in µW to mW. These are also termed as “super-rectifiers”.

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