RURS 2023 School of Natural Sciences Abstract
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The Rice Undergraduate Research Symposium (RURS) is the premiere event for undergraduates across all disciplines to showcase their research. The collective efforts of the Rice community allow for this annual event to highlight and celebrate the incredible scholarly and creative contributions of undergraduate researchers.

Shapiro Showcase, April 10th & 11th
RURS 2023 Co-Chairs: Brendan Frizzell, Hannah Li, & Nafisa Azizi (rurs@rice.edu)
As an undergraduate in 2002, Dr. Jenessa Shapiro founded RURS to give Rice student researchers an opportunity to share their diverse work. Twenty years later, we honor Dr. Shapiro's legacy with the Shapiro Showcase, a competition featuring 16 students across the disciplines who have been nominated and selected by faculty in their respective schools. Presenters will deliver 10-minute talks on their intermediate to advanced research in two sessions - a STEM session and an Arts, Social Sciences, and Humanities session. One winner will be selected through judge evaluations and announced at the closing reception.

Dynamic Control of Energy Transfer in AuNR-PANI Hybrids through pH

This paper presents a multifeed rectenna for high-efficiency RF energy harvesting. By using a multifeed slot loop antenna and co-designing the antenna and the rectifier circuit, the lossy impedance matching network between the antenna and the rectifier is eliminated to boost the RF-to-DC conversion efficiency. Additionally, using multiple antenna feeds extends the high-efficiency region of the rectifier, which in turn, allows for high DC output power and high efficiency simultaneously. A proof-of-concept two-feed rectenna is designed and tested at 960 MHz. It achieves peak efficiency at 64.5% and a combined DC output voltage of 1.72 V at an input power density of 2.3 uW/cm^2, demonstrating state-of-the-art RF energy harvesting performance. When excited with incident light, nanoparticles support localized surface plasmon resonances. The energy offered due to the plasmon's high cross-section absorption can be used in photocatalysis and photovoltaics to increase device efficiencies. Hybridization of nanoparticles with an interfacial energy acceptor has been introduced as a method to capture the charge or energy offered by the plasmon before the ultrafast recombination of electron hole-pairs occurs. Understanding the mechanisms occurring at the interface in hybrid materials is crucial for future optimized device implementations. Charge transfer is one viable mechanism for hybrid materials; however, it requires a scavenger layer to avoid charge imbalance, which leads to eventual dissolution and device degradation. Alternatively, resonance energy transfer offers an avenue for the use of soft polymer at plasmonic interfaces while relaxing the band alignment requirement and allowing for increased processability of metal-organic interfaces. Creating an electron hole-pair in the acceptor eliminates the possibility of charge accumulation on the metal. RET is achieved via dipole-dipole coupling and is most efficient when the spectral overlap between the plasmon donor and polymer acceptor is greatest. Polyaniline (PANI) is a semiconducting polymer with an absorption spectra that shifts across pHs, allowing the RET between AuNR and PANI to be switched on and off maximal efficiency. This project monitors RET efficiency via changes in the single particle linewidth. Single-

particle data correlated across multiple conditions is achieved using a custom-built fluidic cell on an inverted hyperspectral dark-field microscope to collect plasmon spectra in both acidic and basic conditions. This work demonstrates how a tunable soft interfacial acceptor with an AuNR donor can achieve switchable RET as the PANI moves in and out of the region of maximal overlap. Since the single particle linewidth also relies on the morphology of the rod, this work also demonstrates how the degree of RET modulation achievable is reliant on the morphological properties of the individual rod. These results open the possibility of specific AuNR morphologies to be selected in future AuNR-PANI devices to optimize desired electronic properties.