RESEARCHER PROFILE
PROFESSOR NICHOLAS J PINTO

RESEARCH GOALS
Compared with their inorganic counterparts, organic polymer semiconductors have marked potential for the way in which electronic devices are manufactured and used. Not only can these high-potential materials improve efficiency and reduce costs in the production of devices such as solar panels and OLED televisions, scientists are also investigating how they can help advance the development of flexible displays. Continuing to prove their value in studies across the world, the materials boast higher thermal stability, improved compatibility with chemical and biological functionalities, and, above all, enhanced electrical conductivity. It is no wonder, therefore, that capturing this potential is big business.

Despite their wide-ranging potential, organic polymer semiconductors are proving difficult and costly to produce on a large scale. Aiming to make their use in devices and sensors commonplace, Professor Nicholas J Pinto and his team at the University of Puerto Rico (UPR) at Humacao are exploring the fundamental charge transport and storage processes of these polymers. What is more, Pinto is involving a group of undergraduate students in his work, fulfilling another ambition: to engage and motivate the next generation of researchers to pursue a career in STEM.

ELECTROSPUN POLYMER FIBRES

OBJECTIVES
• To understand fundamental charge transport/charge storage processes in conducting, semiconducting and electro-active polymers
• To create nanofibres using electrospinning for the fabrication of better electronic devices and sensors
• To train and inspire the next generation of scientists toward higher education and professional careers in science

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NICHOLAS J PINTO has a PhD in Physics from Montana State University, USA, and is now a professor at the University of Puerto Rico at Humacao. His research includes electrospun polymer fibres for use in organic electronics at the nanoscale. A co-inventor on two US patents, and the author or co-author of several publications, his focus is to motivate undergraduate students to seek advanced degrees in science and engineering.

METHOD
Pinto’s team judged that in order to fabricate better devices and sensors using electro-active polymers and their composites, their fundamental mechanisms of charge transport and charge storage must be properly understood. A process known for its simplicity, efficiency and low cost, the key to realising their manufacturing aim has been electrospinning, which the UPR team is using in an intriguing and unique way to create polymer nanofibres.

Prior to electrospinning, the first port of call for Pinto’s team was taking temperature-dependent conductivity and dielectric permittivity measurements (DPMs). Nanofibres naturally possess a confined environment for charge flow. As a consequence, any defects are likely to lead to changes in charge transport. “These defects give us a handle on how best to prepare a defect-free nanofibre,” Pinto explains. “Notably, DPMs on nanofibres will also shed light on charge relaxation processes in a confined environment.” The team found that due to the nanofibres’ small diameter and, therefore, large surface-to-volume ratio, the materials have the potential to be used in the fabrication of low-power consumption devices and supersensitive and rapid-response sensors. In creating these nanofibres, Pinto is endeavouring to combine materials that possess different electronic, mechanical and optical properties.

IMPACT
The team has already enjoyed great success in preparing nanofibres from electrospinning, particularly in the recent preparation of polylactic acid (PLA) blended with the conducting polymer polyaniline doped with camphor-sulfonic acid (PANI-CSA). The former being a thermoplastic, biocompatible and biodegradable polymer, and the latter being a common conducting polymer known for its natural ability to synthesise. While their pairing is not new, Pinto’s team is the first to prepare the nanofibre at the lowest PLA concentration recorded in the literature.

The group has identified that the PLA/PANI-CSA nanofibre has the potential for reducing the toxicity of electronic devices. Remarkably, the findings can even have applications in 3D printing of mechanical parts for bone repair. Establishing these new methods of combining polymer materials will undoubtedly lay the foundations for incorporating nanofibres into electronic devices.

Ultimately, the impact of this research stretches beyond the creation of improved devices. Pinto hopes that exposure to a broad range of subjects – in this case, physics, nanoscience, polymer science and electronics – will increase the number of students participating in scientific research. Students currently involved in Pinto’s research are being trained in the scientific methodology and gaining sound and relevant research experience. “These opportunities will not only help them in their graduate studies, but also improve their future employment opportunities,” Pinto enthuses.