# Mechanical and thermoelectric properties of single wall carbon nanotube-polyurethane composite sheets

SCIENTIFIC AREA: Nanotechnologies

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## Background

Thermoelectric (TE) materials of non-conductive polymers and carbon nanotubes (CNTs) are subject of research due to the low k and high flexibility of the polymer as well as the excellent power factor ($PF=S^2\sigma$) of CNTs. Notably, a literature survey in this topic reveals that most TE polymer composites consist of intrinsically conducting polymers (ICPs). This is due to their high electrical conductivity and great biocompatibility, even if their mechanical properties and flexibility are limited. In contrast, few studies present the TE and mechanical properties of polyurethane (PU)/CNT composites, despite that the PU represent an ideal choice for flexible TE materials because of its high stretchability, good tensile strength, impact performance, and corrosion and abrasion resistance.

## Outcomes and results to date

P-type CNT–thermoplastic polyurethane (TPU) sheets with high contents of single wall carbon nanotubes (SWCNTs) (up to 90 wt%) are produced in this work by employing a one-step filtration method (Figure 1). Their tailored TE and mechanical properties, which are controlled by varying the SWCNT/TPU wt% ratio in an optimized solvent system, show significant advantages relative to the pristine SWCNT buckypaper (BP) sheets. In particular, the SWCNT–TPU nanocomposite with a 50/50 wt% ratio (15 vol% of SWCNTs) shows a PF of 57 $\mu W\ m^{-1}\ K^{-2}$, slightly higher than the PF of the SWCNT BP prepared under the same conditions, while its mechanical properties significantly increased (e. g., ~7-, 25-, and 250-fold improvements in stiffness, strength and tensile toughness, respectively) (Figures 2 and 3).

## Relevance to the state-of-art

By a scalable process, consisting of commercial materials combined in a solvent/nonsolvent system in a single-step, this approach presents a route to other TE materials (e.g. ICPs and CNT´s buckypapers) to obtain flexible and robust p-type units for energy harvesting modules based on the TE effect.

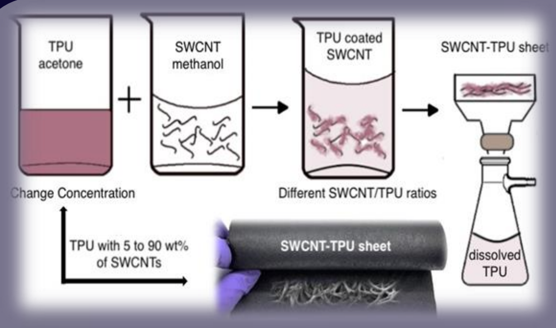


Figure 1. One-step filtration method to fabricate nonwoven SWCNT–TPU sheets.

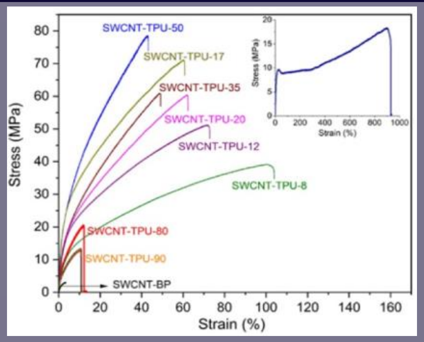


Figure 2. Stress-strain for SWCNT BP, SWCNT–TPU sheets and neat TPU (insert).

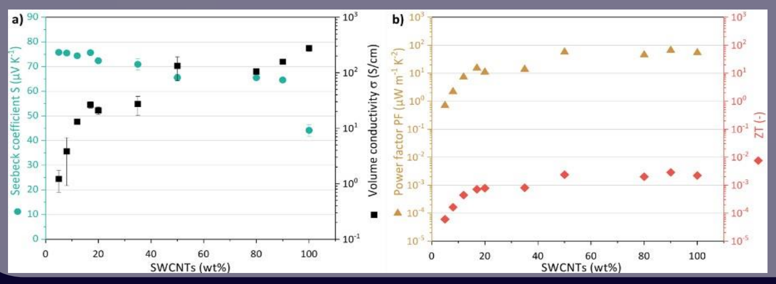


Figure 3. TE properties of SWCNT–TPU sheets and SWCNT BP. (a) σ and S, (b) average PF and ZT.

## Reference

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## Partnerships

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