Development of a recyclable and conductive NIPU composite for advanced applications

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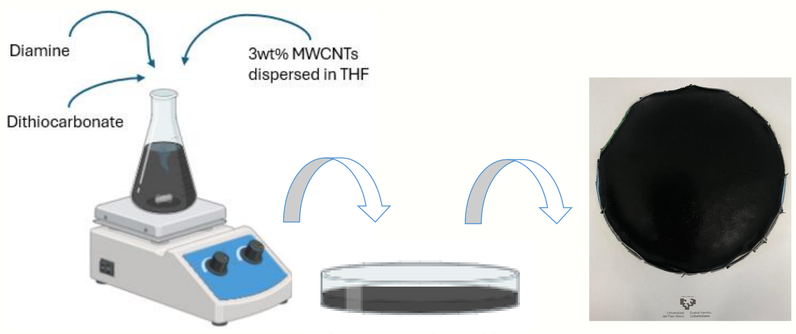
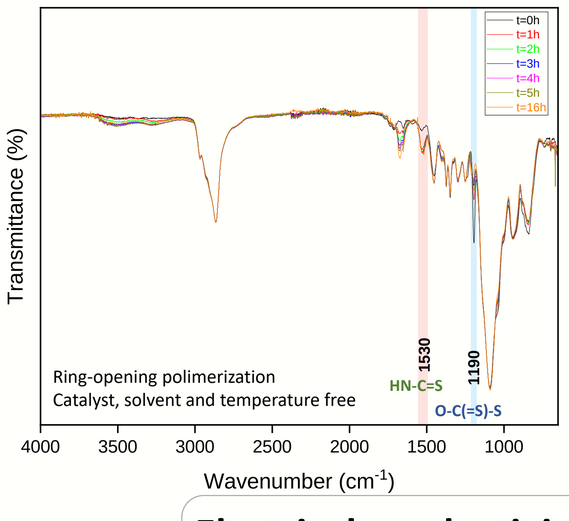
INTRODUCTION

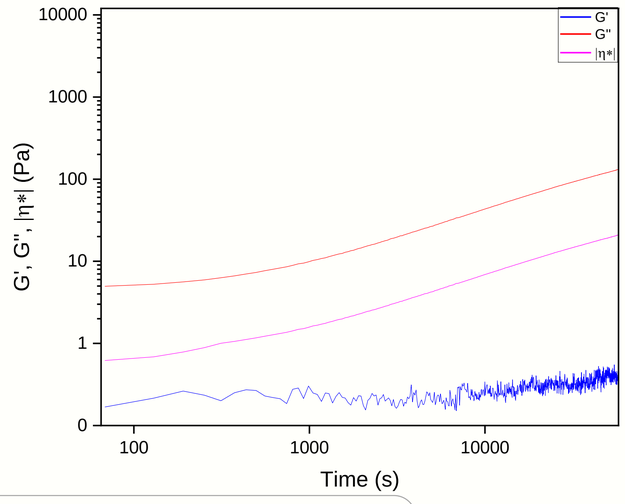
The use of diisocyanates in the synthesis of conventional polyurethanes raises significant environmental and health concerns due to their toxicity and the emission of harmful substances during production. Non-isocyanate polyurethanes (NIPUs) have emerged as a promising alternative, offering a more sustainable and safer route to polyurethane-based materials. This study presents a catalyst-free, bulk synthesis method for a thiol containing NIPU. To enhance its functionality, a novel composite material was developed by incorporating 3 wt% of multi-walled carbon nanotubes (MWCNTs) into the NIPU matrix. The resulting material exhibited enhanced electrical conductivity, making it suitable for a variety of electronic and energy applications. Furthermore, the NIPU/MWCNT composite demonstrated excellent recyclability due to the presence of dynamic sulphur-based linkages in its structure.



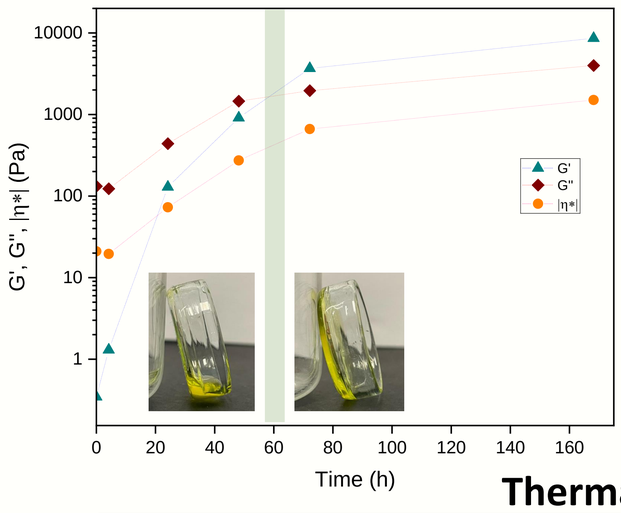
RESULTS

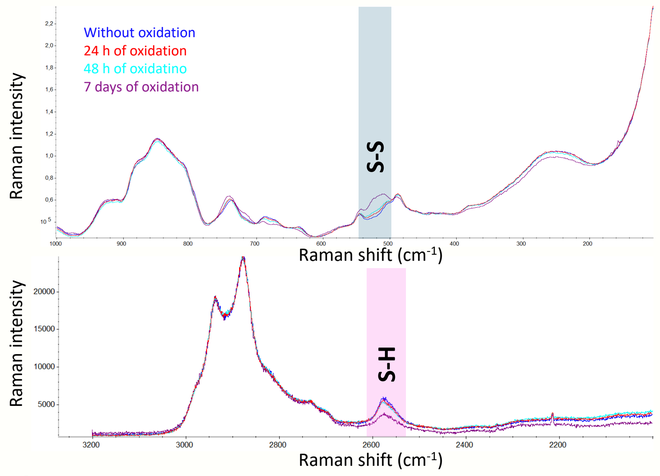
Synthesis of NIPU-SH





Oxidation of S-H into S-S

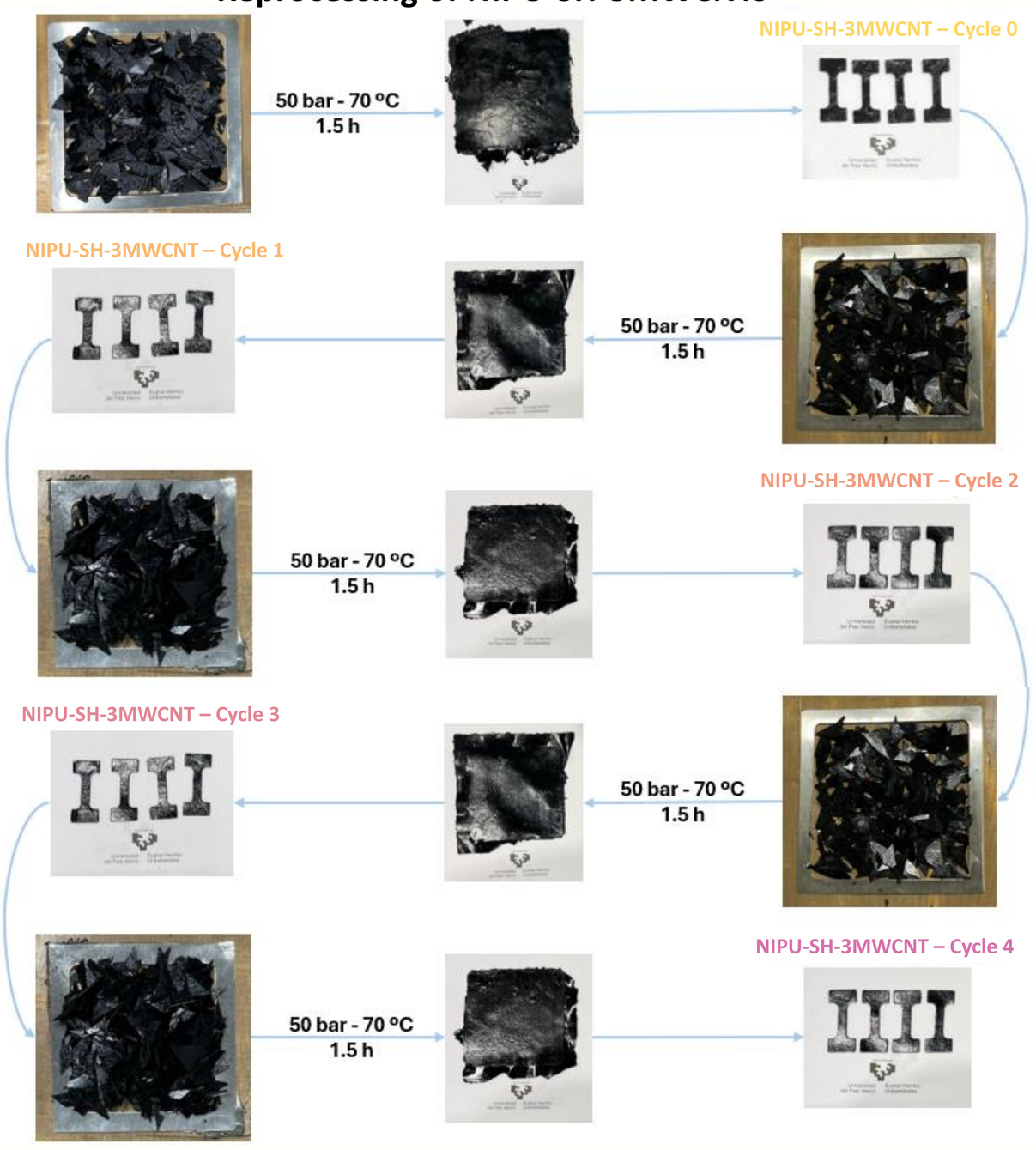




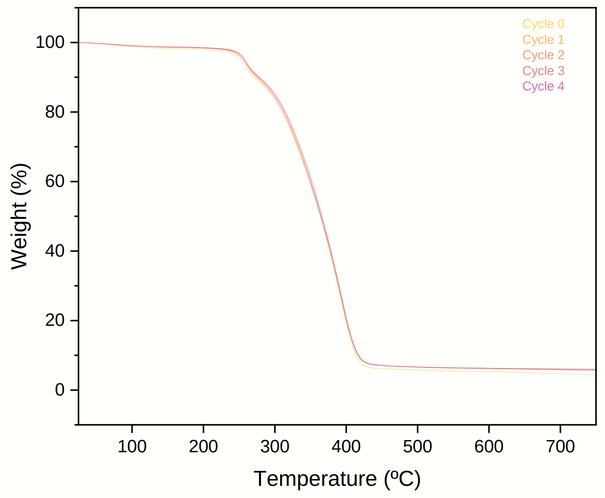
Electrical conductivity of NIPU-SH-3MWCNT

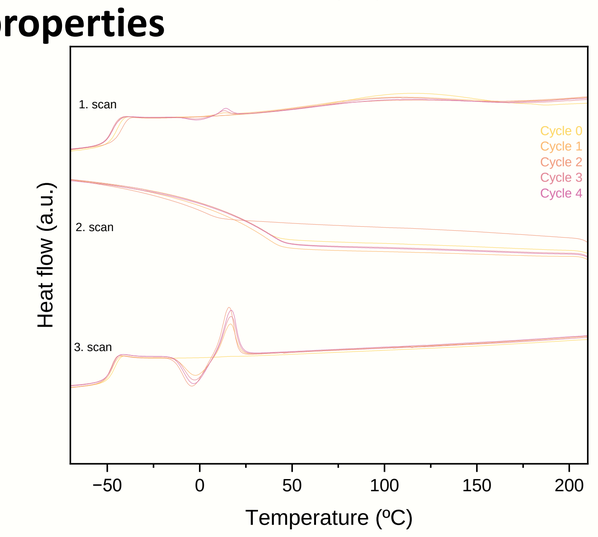
$\sigma = 8.26 \times 10^{-5}$ S m^{-1}

Reprocessing of NIPU-SH-3MWCNTs

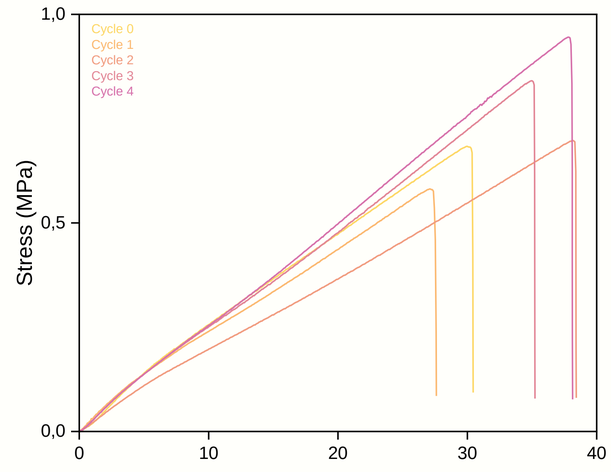


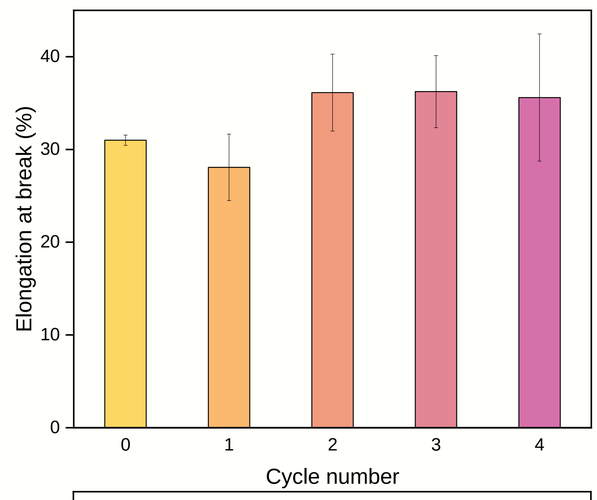
Thermal properties

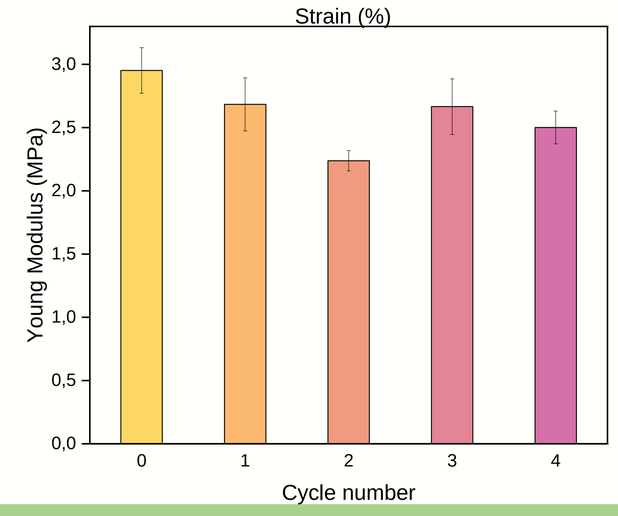


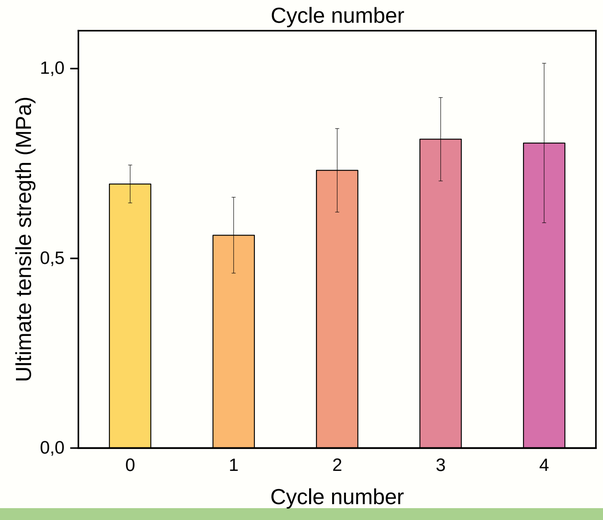


Mechanical properties









CONCLUSIONS

The material was successfully recycled up to four times in a hot-plate press with minimal loss in thermal and mechanical properties, highlighting the robust and sustainable nature of the NIPU-based system. This work not only addresses the challenges associated with conventional polyurethanes but also provides a promising pathway for the development of recyclable, conductive polymers for their use in sustainable electronics and other advanced material and energy applications.

Acknowledgments

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