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RESEARCH SCHOOL OF CHEMISTRY AND APPLIED BIOMEDICAL SCIENCES

Design of Composite with Enhanced Photothermal and Conductive Properties Based on Recycled PET and UiO-66

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The concept and actuality of the work

Without C-X bond breakage — Mechanical recycling
More practical, but plastic deteriorates

Kim et al., *J. Appl. Polym. Sci.*, **2012**, 128, 1250
Gong et al., *Polym Eng Sci.*, **2011**, 51, 1023

Partial C-X bond breakage — Functional recycling
High value-added material, but technology development is needed

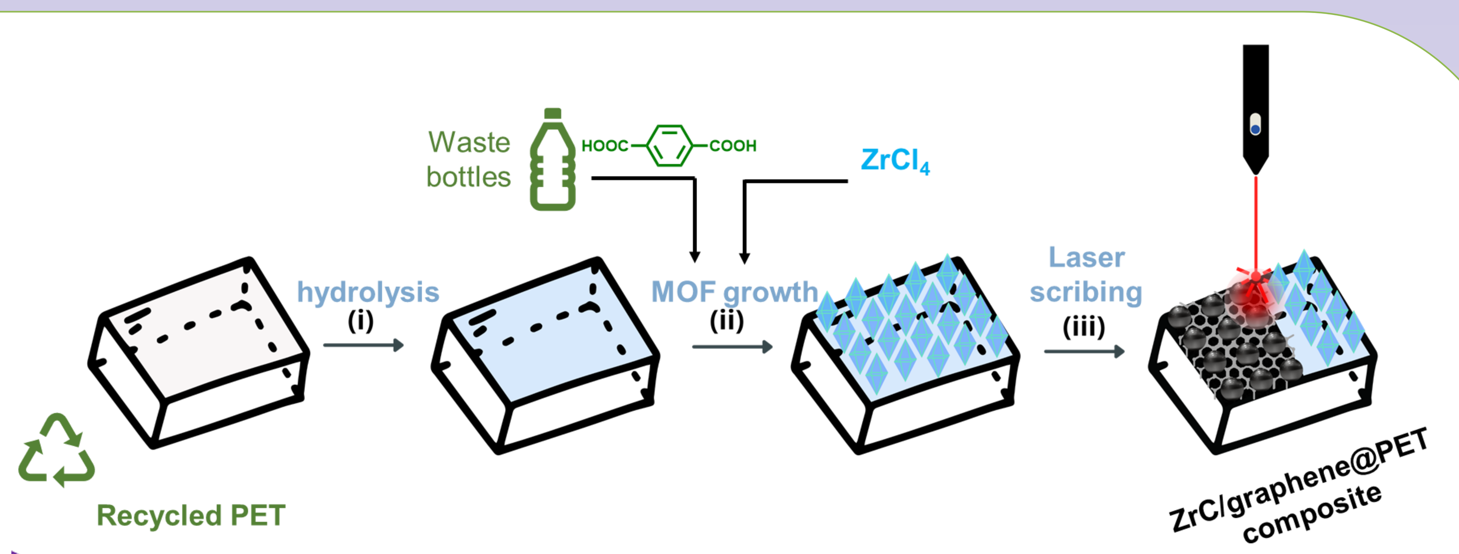
Zinchenko et al., *J. Environ. Chem. Eng.*, **2021**, 9, 106129
Lambropoulou et al., *Chemosphere*, **2019**, 234, 746

Complete C-X bond breakage — Chemical recycling
Higher quality polymers, but high temperature and catalysts required

Sinha et al., *J. Polym. Environ.*, **2010**, 18, 8
Farahat et al., *Macromol. Mater. Eng.*, **2005**, 290, 13

C-X bond breakage degree, %

O. Guselnikova, O. Semyonov, E. Sviridova, R. Gulyaev, A. Gorbunova, **D. Kogolev**, A. Trelin, Y. Yamauchi, R. Boukherroub, P. Postnikov, *Chem. Soc. Rev.*, **2023**



Kogolev et al., *J. Mater. Chem. A.*, **2023**, 11 (3), 1108

✓ Conductivity
✓ Photothermal conversion
✓ Mechanical stability

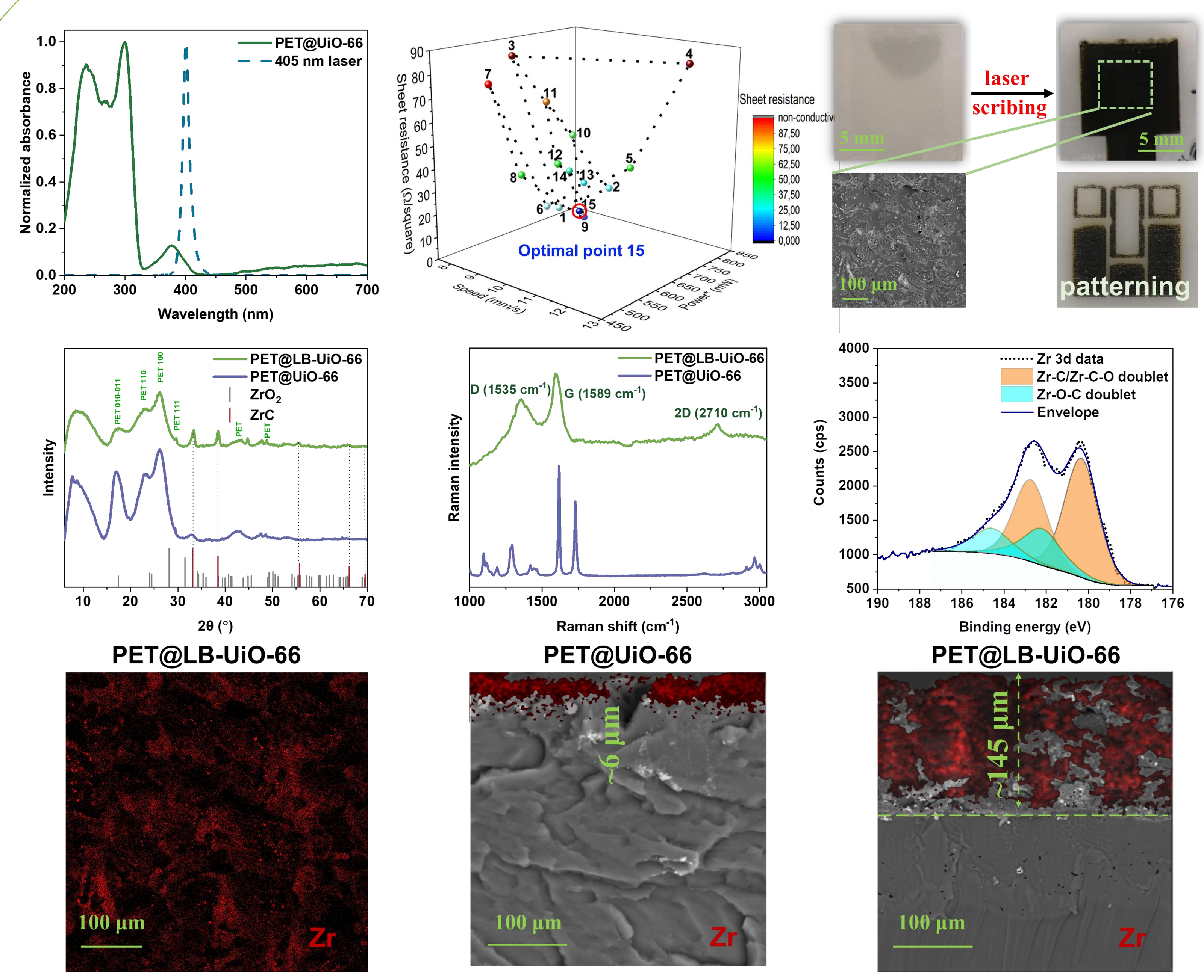
Thermal annealing

- Harsh conditions;
- High energy costs;
- Process duration;
- Substrate application

Laser ablation

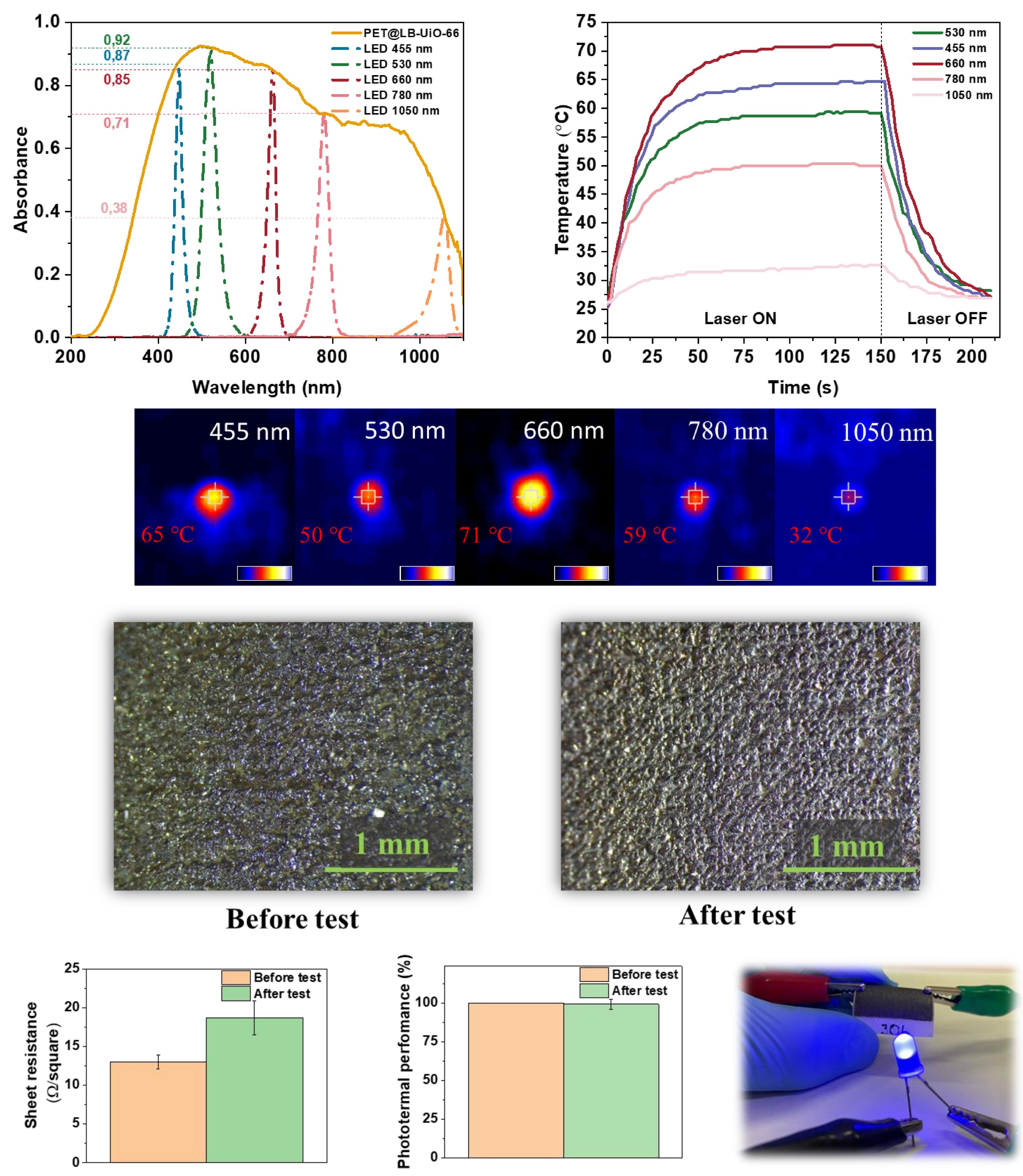
- No metal particles aggregation;
- Economically and energy-efficient;
- Process time reduction;
- Possibility of creating different patterns

Characterization



- Optimization of laser parameters for the carbonization process according to the Nelder-Mead method;
- SEM – formation of a homogeneous carbonized layer(high surface conductivity of 10,4 ± 3,1 Ohm/square);
- Ability to carbonize predefined patterns;
- XRD (33.2, 38.4, 55.7, 66.2 and 69.6°);
- Raman (characteristic peaks; I_D/I_G = 0.94);
- XPS (ZrC: Zr 3d – 180.3 and 182.7 eV);
- Cross-SEM-EDX (Marangoni effect)

Applicability and mechanical stability



- Reducing the band gap of the composite material after carbonization (from 3.04 to 1.05 eV);
- The ability of a material to exhibit a photothermal effect with excellent thermal conductivity (ZrC);
- Relatively low power LED sources are required to excite the photothermal effect;
- Formation of a mechanically stable carbonized layer (without loss of photothermal properties and conductivity);
- The composite can be used as a conductor for LEDs or other circuits

Conclusion

A novel approach for the smart upcycling of waste PET to create conductive materials with excellent photothermal properties through the surface-assisted growth of UiO-66 and subsequent laser-induced carbonization

Acknowledgements

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