Laser Induced Selective Activation (LISA) Improves Electrical and Piezoresistive behaviour of Polymer Nanocomposites.

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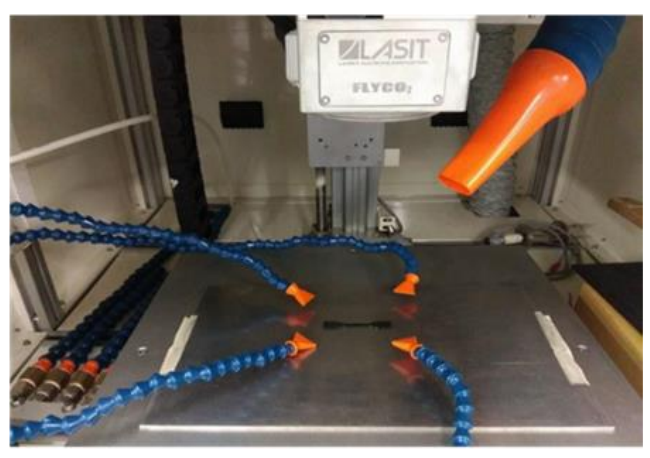
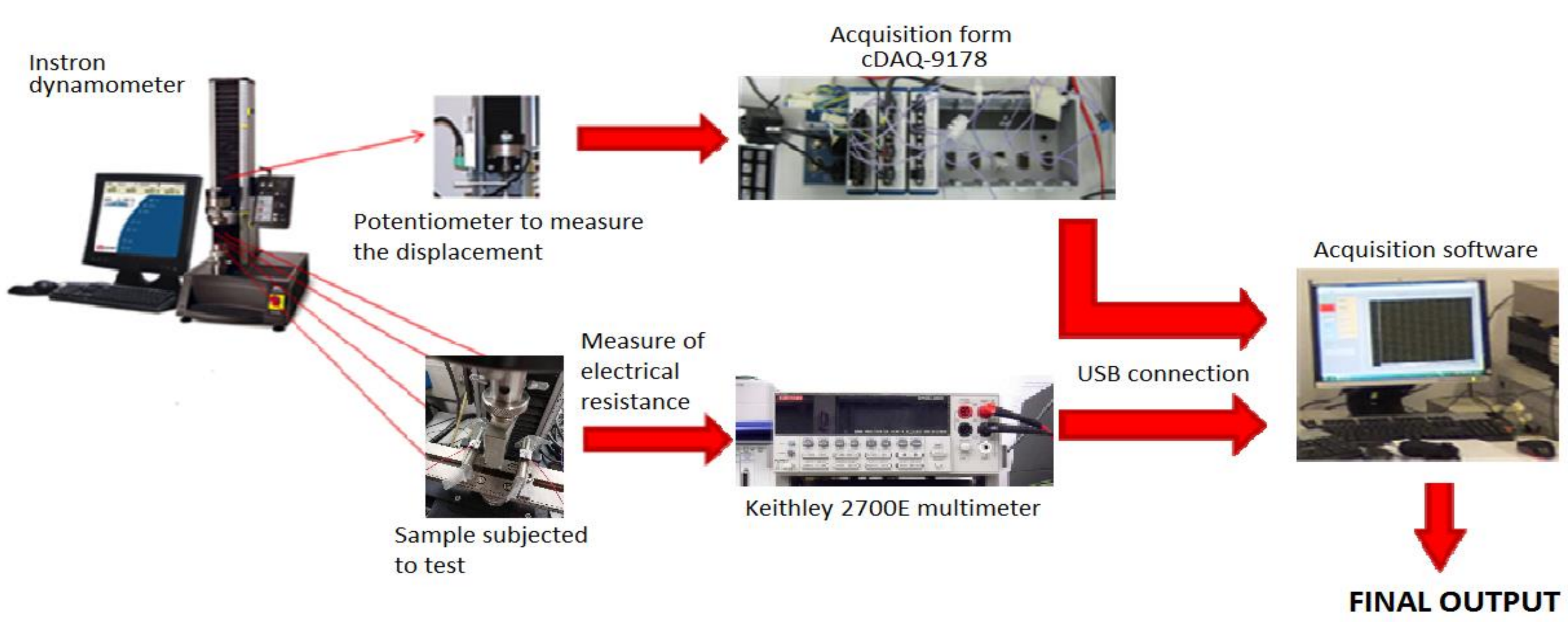
INTRODUCTION

Laser patterning process named LISA (laser Induced Selective Activation) could represent the novel industrial strategy for the production of multifunction nanocomposite parts and their first application in interior components of vehicles The current industrial practice is based on an “add-on” philosophy while our concept is based on “in situ” functionalization. This new approach consists in the creation of devices directly inside tailored polymer based nanocomposites by means of laser treatment conductive carbonaceous residue that greatly increases conductivity by bridging among conductive nanofiller particles. The CO_2 laser machine used for this purpose is the model Towermark XL of LASIT S.p.a. Company. The wavelength of laser radiation is 10600 nm, in the order of middle infrared light spectrum. The maximum radiation power emitted by laser is 100W emitted in pulse mode. The excitation mode of the active material is radio frequency, with the generator integrated in the laser tube.

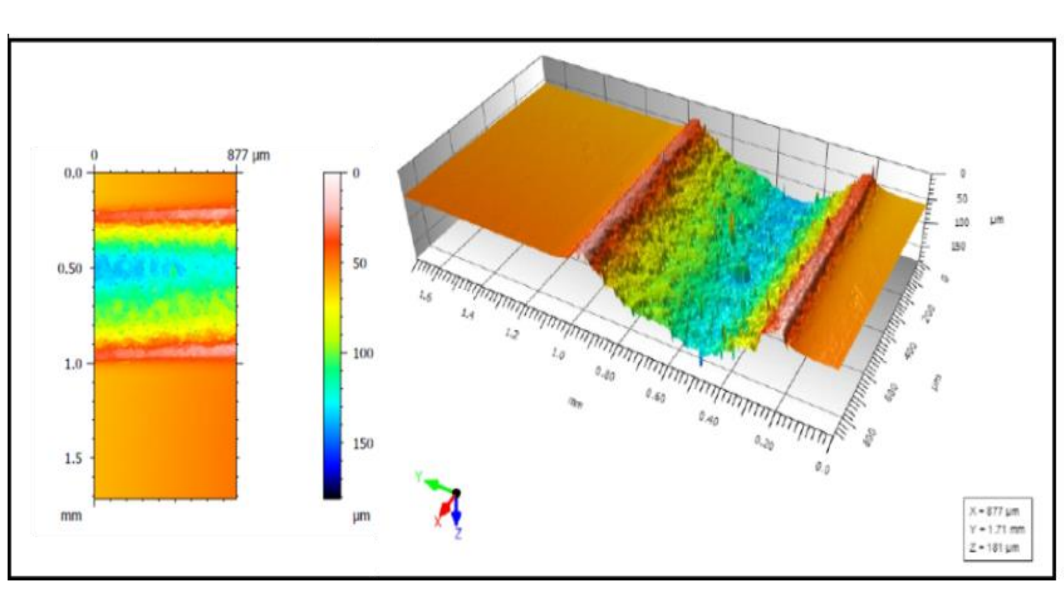


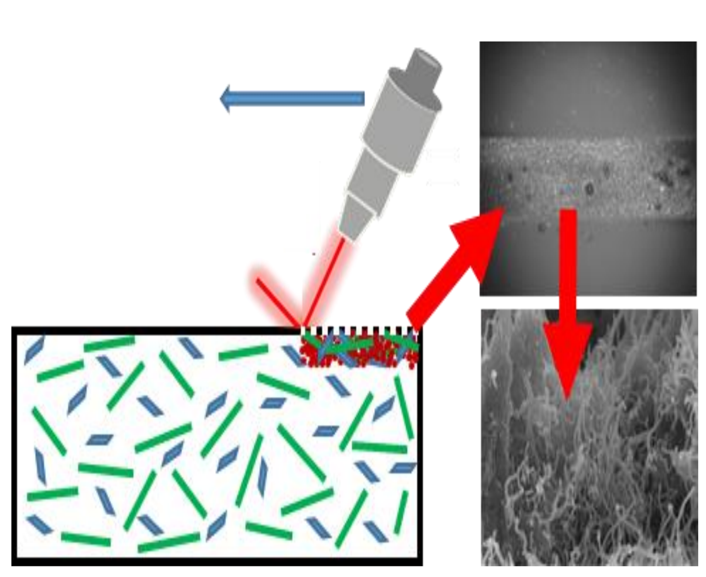


OBJECTIVES

The goal is to develop a complete automotive wireless dashboard (upper instrument panel and steering wheel) with conductive patterns, sensors and devices based on multi-functional polymers with carbonaceous fillers. This will allow to remove copper (Cu) wiring and buttons currently used in dashboards, reducing production steps and weight, while improving esthetics and disposal/recyclability. The work already performed by CRF within the Graphene Flagship, the wide range of graphene and related materials (GRMs) produced at tons scale and the mature processing techniques make our goals ambitious but feasible. We will use the multi-functional properties of GRMs to selectively modify the electrical conductivity of the dashboard polymer material allowing internal signal transport, wireless conductive circuits, sensors and switches to communicate with the environment and with the human user. The technological challenge is to produce “in-situ” metal-free electric circuits with a linear surface resistance <0.5 kΩ/cm. This will not require us to match the CU properties, but just to achieve a bulk conductivity~10 S/m.

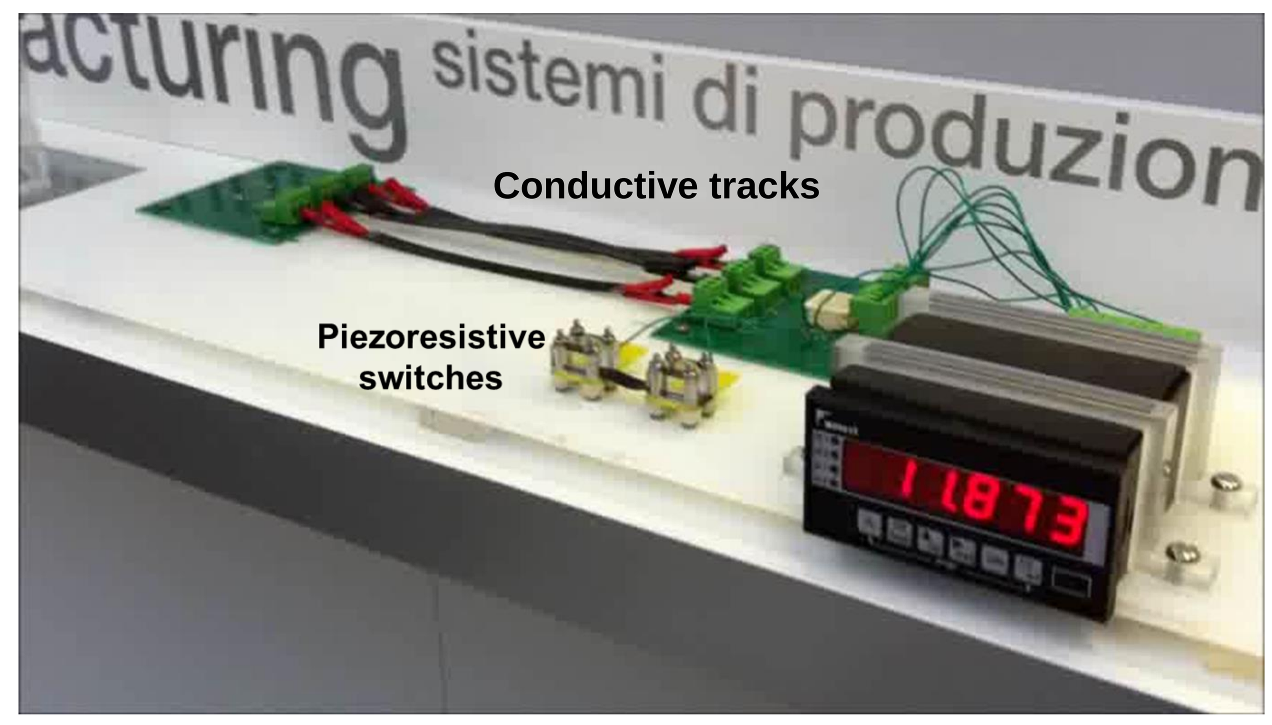
The most challenging effort will be finding and testing all polymeric matrices of the dashboard in order to find a proper GRM concentrations for each polymer that shows conductivity and piezoresistivity only after the LISA process. The main functionality that this technology could replace will be the pressure sensors (switches and knobs) and the electrical circuit for the stirring wheel electric heating.



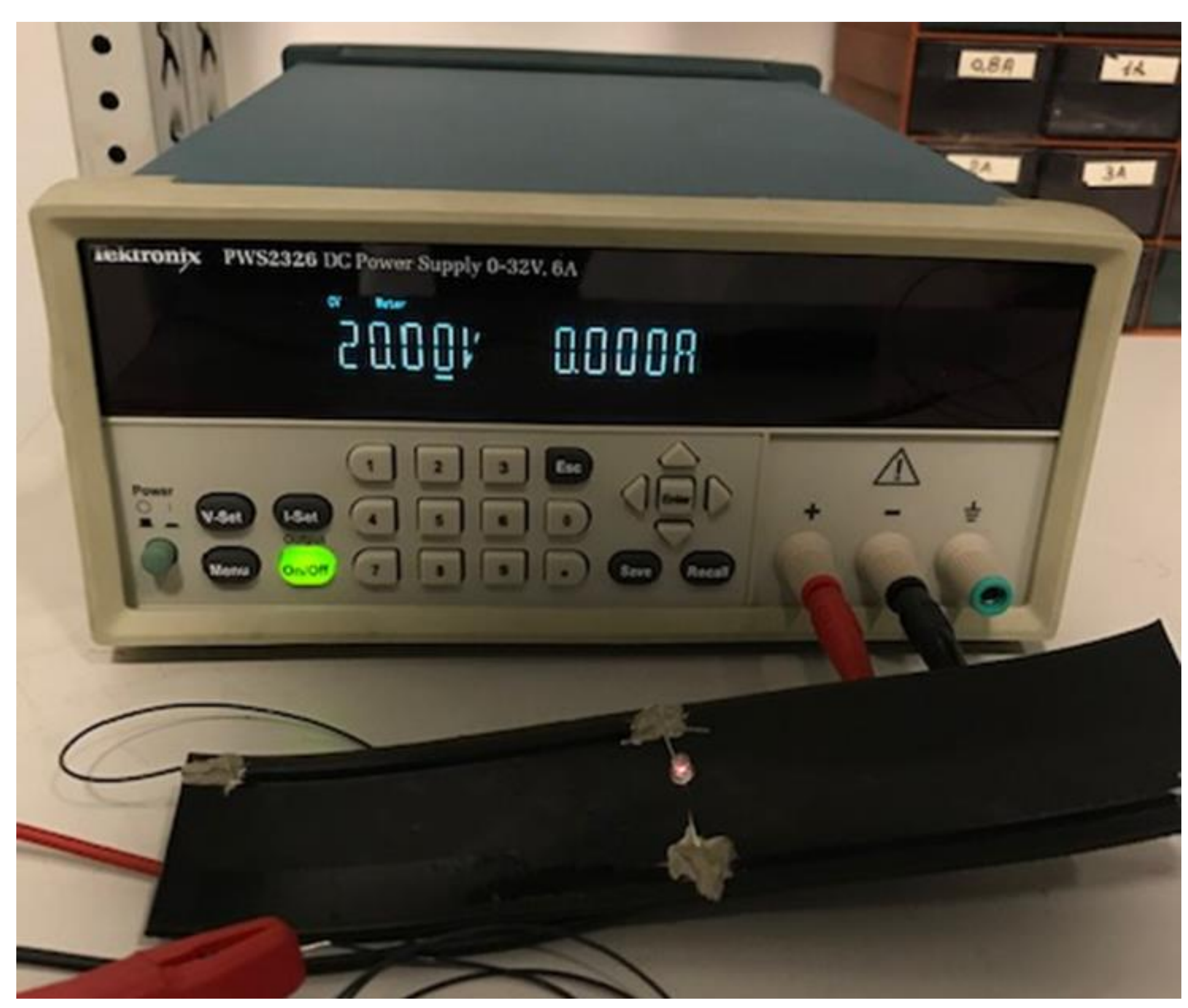


CONCLUSIONS

Laser treatment was successfully used for producing conductive tracks on the surface of polymer-nanofiller composites with a filler content lower than the percolation threshold for electrical conduction. In general, the final resistance of these tracks depends on the kind of filler and matrix, and the laser processing parameters. Conductive tracks can be more easily obtained when using CNTs, while to obtain the same result higher concentration of GNPs are required. The addition of a small quantity of graphene allows to reduce the content of the CNTs because of a synergetic effect between the two fillers, thus making the material cheaper. Very different resistance values were observed when surface treating different polymer matrices filled with the same concentration of CNTs.



MAIN BENEFITS
- ✓ Metal wiring and button switches removal
- ✓ Weight and cost reduction
- ✓ Assembling simplification
- ✓ Easy recycling at ELV
- ✓ Improved perceived quality



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