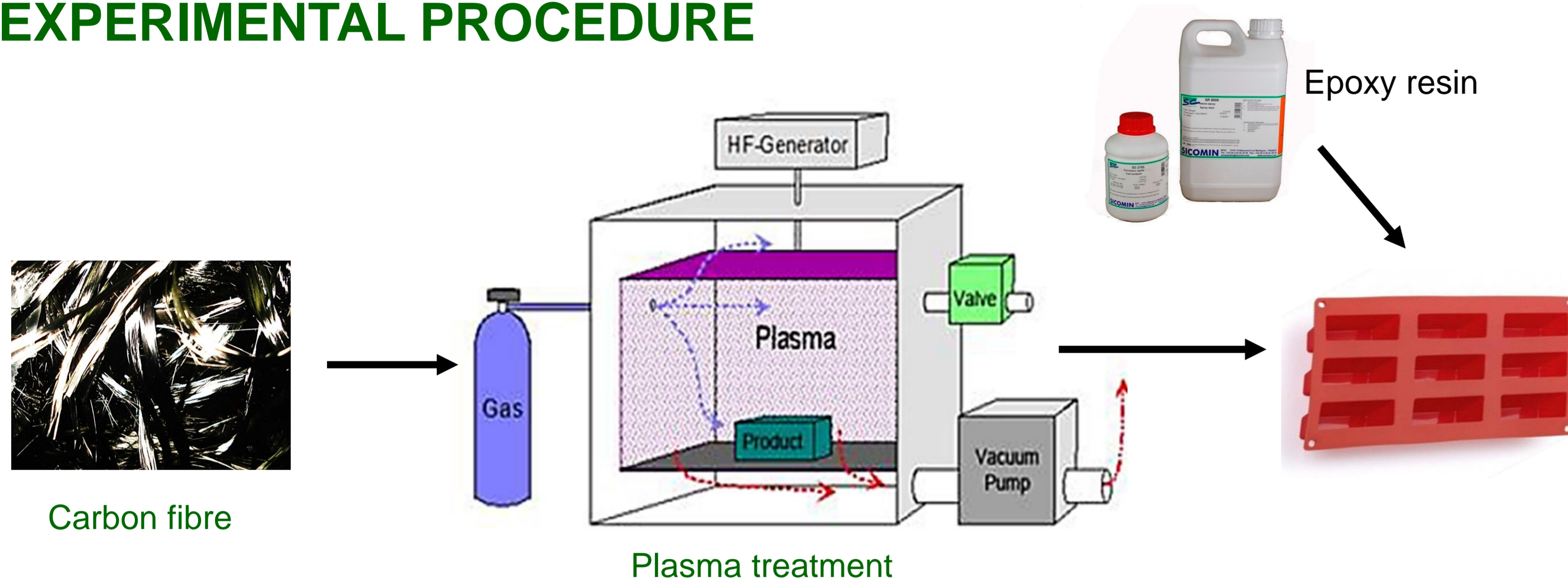


## INTRODUCTION

The volume of carbon fibres that are discarded in the production of structures (airplanes, automobiles...) either in the form of fabric scraps, expired prepregs or defective parts is increasing day by day. Moreover, in a few years these structures will become obsolete and will need to be recycled. At the moment, CFRP recycling and manufacturing residues are being recycled mechanically by shredding, which produces carbon fibres of 1 mm in length. As a result, a major part of their economic value is lost. Therefore, we are working on recycling processes for long fibres (between 2 and 10 mm).

One of the major problems in composite materials reinforced with short carbon fibres is to determine the critical fibre size and its ability to adhere to the polymeric matrix. Therefore, it is possible to reach fibre length sizes that can be considered as continuous fibres depending on the applications. In this paper we present the results obtained for an epoxy matrix CFRP with different fibre lengths. It is also being studied the possibility of improving the strength of the fibre-matrix bond by plasma treatment of the carbon fibres in a low pressure chamber immediately before impregnating them with epoxy resin.

## EXPERIMENTAL PROCEDURE



A unidirectional composite material is prepared with an epoxy matrix (Sicomin SR8500 resin + Sicomin SD8601 hardener in a ratio of 100:35) and 15 wt.% of carbon fibres (supplied by Mel composites) of different lengths (10, 18, 25, 40 and 100 mm).

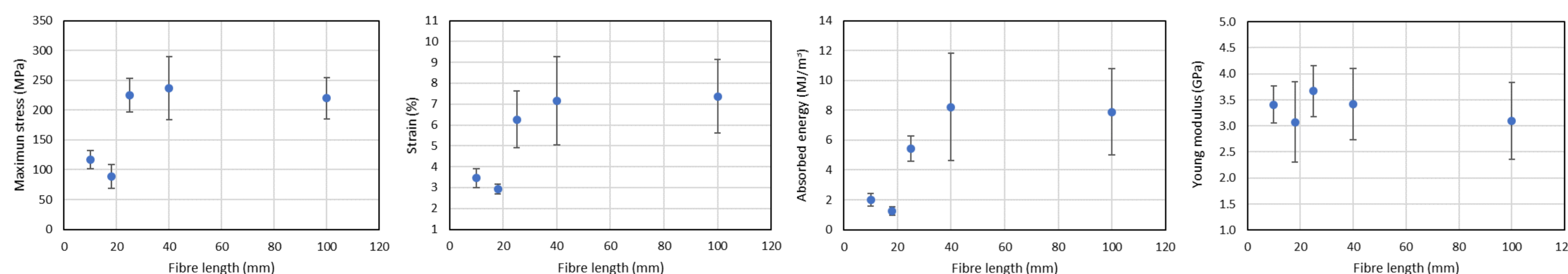
The 105x6x7 mm prismatic specimens were post-cured at 80°C for 8h to ensure the optimum properties of the matrix

The specimens with 100 mm fibres can be considered as continuous fibre.

The specimens were tensile tested with a strain rate of  $5.8 \times 10^{-2} \text{ s}^{-1}$  (0.05 mm/min).

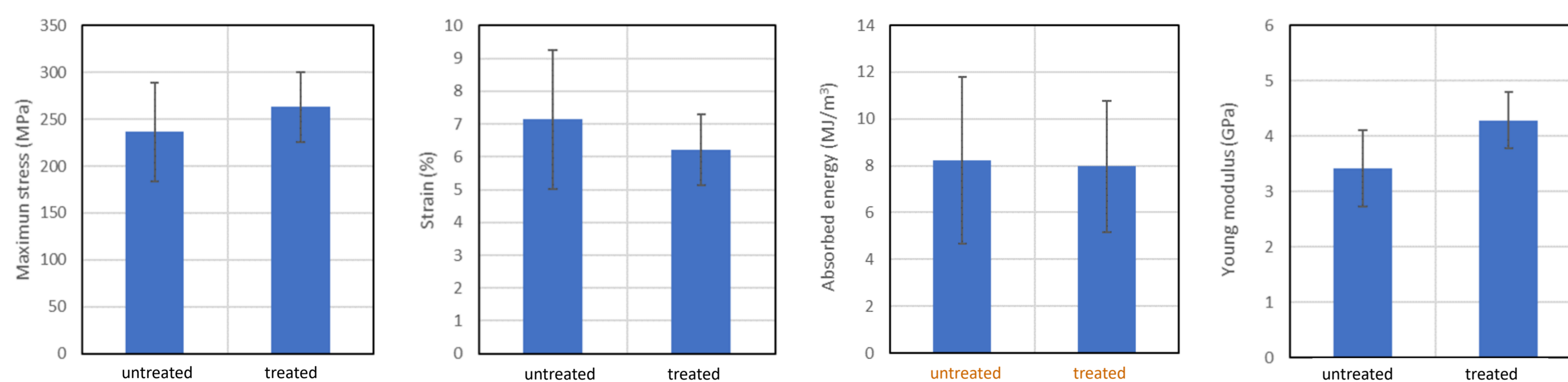
## RESULTS

### Tensile test results of composites with untreated fibres of different lengths



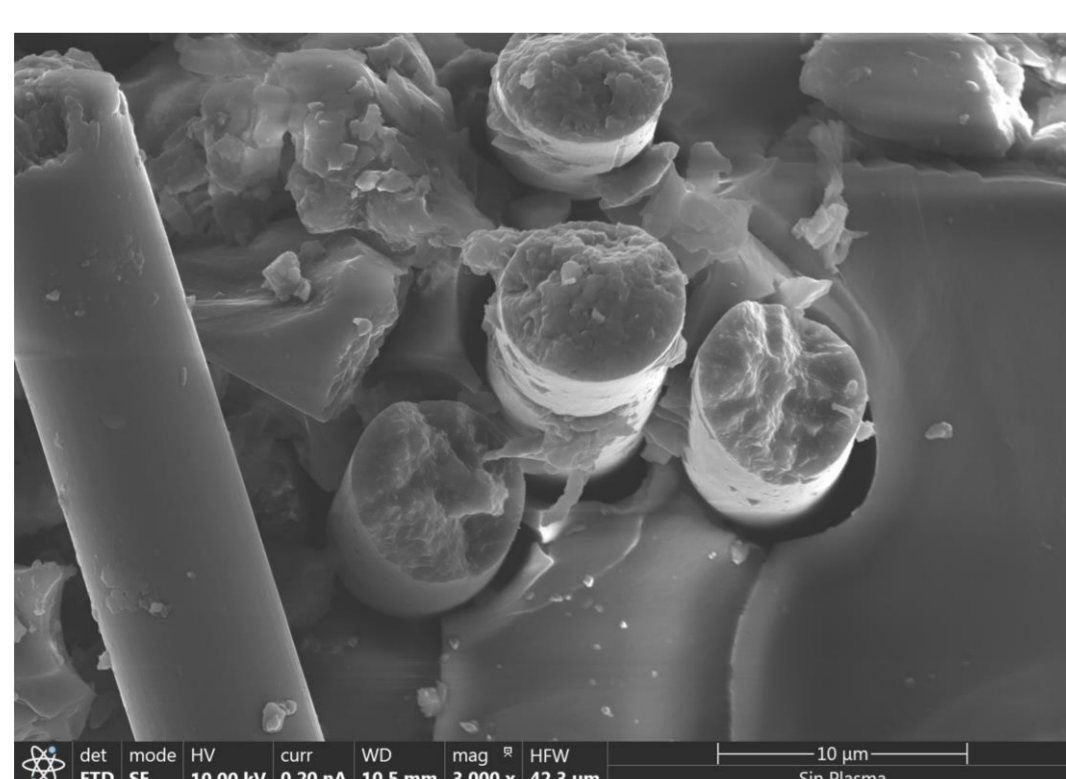
Ten tests have been repeated for each fibre length, presenting the mean values and their deviations of the tensile strength and the maximum deformation obtained before breakage. By means of analysis of variance (ANOVA), it was found that there were no significant differences between the 25, 40 and 100 mm sets, while there existed significant differences between the 10, 18 and 25 mm sets. Comparing with continuous fibre (100 mm in this case), it seems that up to 40-25 mm the composite has the same behavior.

### Comparison of results of composites with 40 mm long plasma-treated and untreated fibres

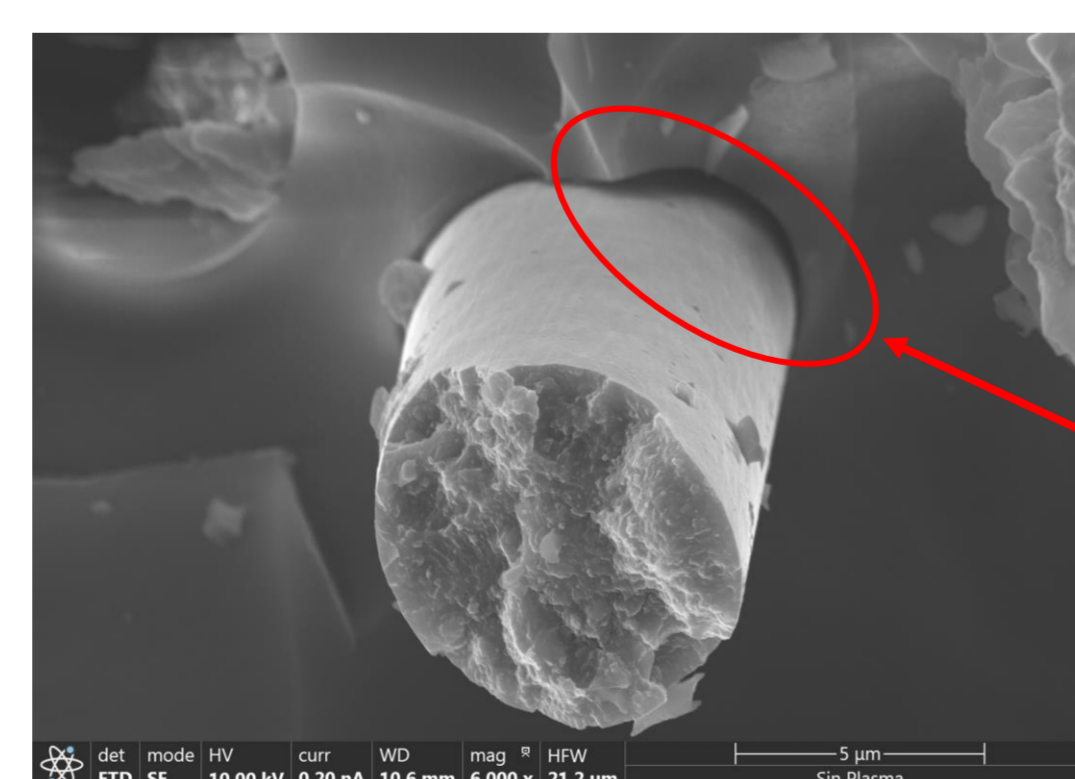


Composites with plasma-treated fibres show a small increase in tensile strength and lower deformation before failure and an increase in Young's modulus. Less dispersion is also observed in the results. This indicates better fibre-matrix adhesion after plasma treatment.

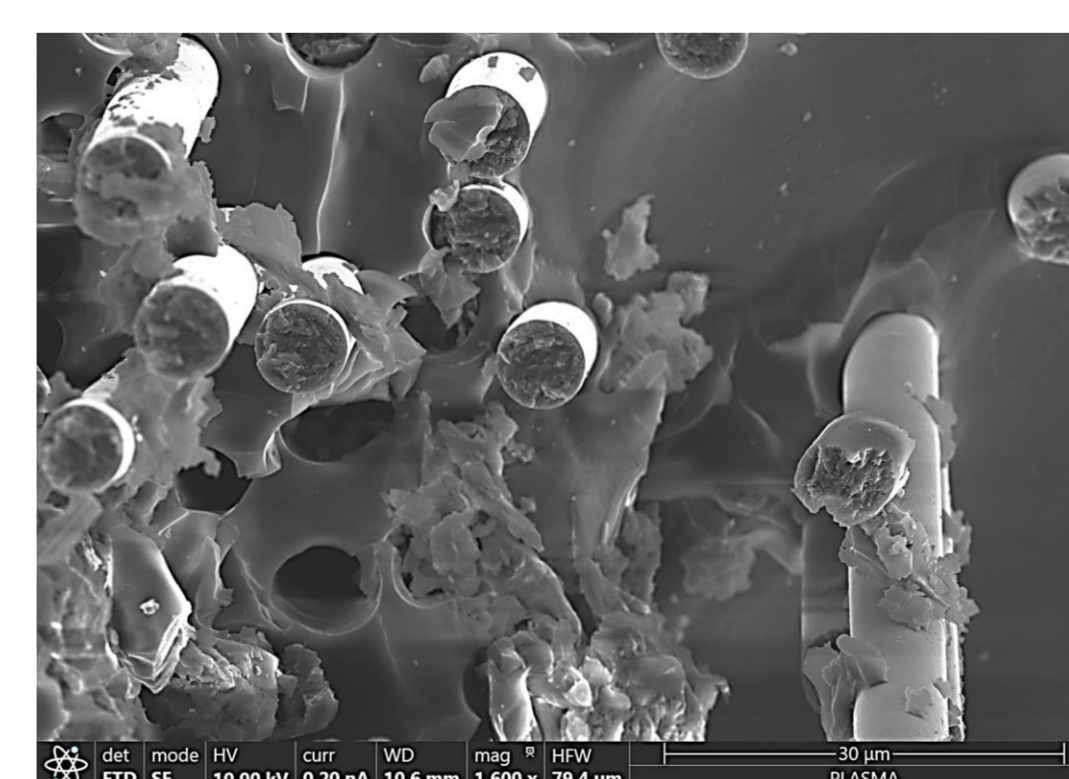
This better adhesion is verified by scanning electron microscopy (SEM).



Composite obtained with carbon fibres without pretreatment



Lack of adhesion



Composite obtained with plasma-treated carbon fibre

## CONCLUSIONS

In this study, it has been proved that the fibre length of 40 mm can be considered as continuous fibre according to tensile test results. In this way, it will be possible to manufacture parts with recycled fibres of low responsibility, being able to consider them as continuous fibres.

To improve the previous effect, the treatment of the fibres by means of low pressure air plasma improves the fibre-matrix adhesion and, therefore, the transmission of stresses from the matrix to the fibres, improving the strength and stiffness of the material.