CIRCULAR ECONOMY IN THE WIND SECTOR: RECYCLING AND REUSE OF CARBON FIBERS FROM END-OF-LIFE TURBINES

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Nano Innovation 2026 Rome, 14-18 September Conference & Exhibition

Introduction

Wind power is a key renewable energy source, but the growing number of End-of-Life (EoL) wind turbines is generating increasing amounts of waste. While up to 90% of a turbine's mass can be recycled, composite blades remain a major challenge due to their complex structure, mainly consisting of glass fiber-reinforced polymers (GFRP) and, to a lesser extent, carbon fiber-reinforced polymers (CFRP).
Carbon fibers are particularly valuable because their production is energy-intensive and costly, whereas recycling requires significantly lower energy and cost. Recovering carbon fibers from EoL blades can therefore support resource efficiency and circular economy goals.

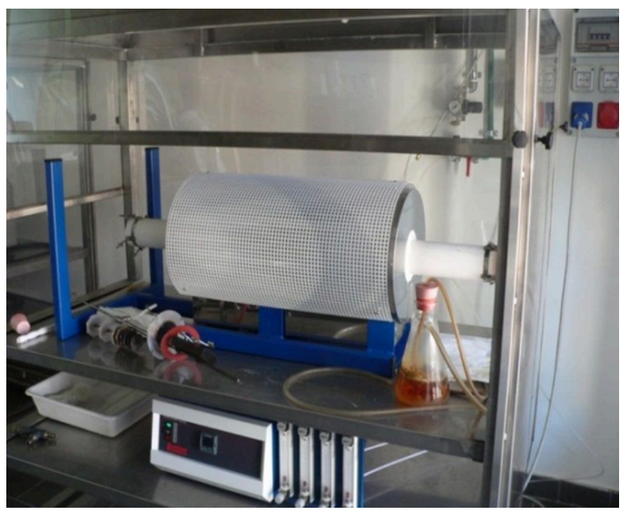
Objective

- Assess the feasibility of different recycling routes for the recovery of carbon fibres from thermoset composites used in the wind energy industry.
- Characterize the recovered fibres to evaluate their properties and quality.
- Investigate the potential reuse of recovered carbon fibres in new applications.

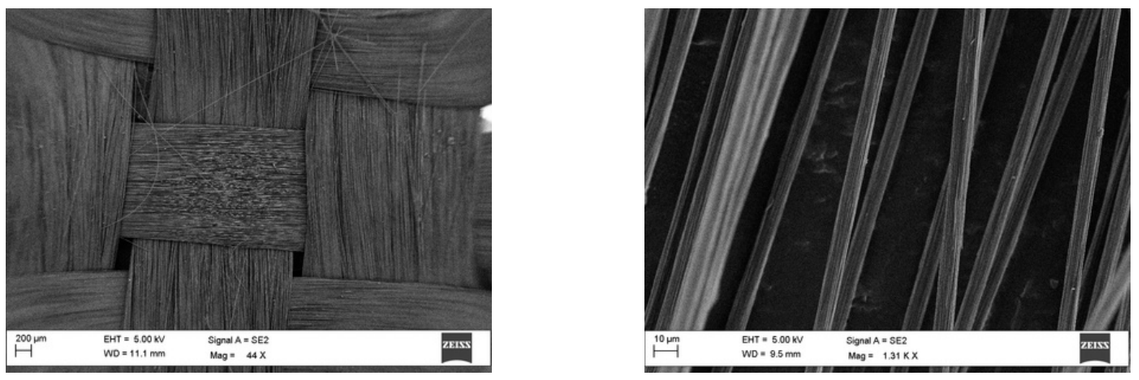
Experimental

Waste Materials	Epoxy/CFRP scrap composites
Recovery process	I - Thermal-based method under reactive atmosphere at temperatures in the range 500-600 °C [1] II - Molten salt-based method under inert atmosphere at temperatures in the range 350-450 °C [2]

Result



Tubular Lenton furnace, used for the batch thermal treatments



SEM images of rCF at different magnification

New applications: composite filaments (left), aerogel (center), felts (right)

Material	Treatment	T (°C)	Reactive gas
Epoxy/CFRP	salts A +B	450	N2
Epoxy/CFRP	salts A +B	450	N2
Epoxy/CFRP	Traditional	550	Air
Epoxy/CFRP	Traditional	550	Air
Epoxy/CFRP	salts A+C	400	N2
Epoxy/CFRP	Salt A	450	N2

Conclusion:

The recycling processes are able to recover carbon fibers of good quality.
The use of rCF for the production of filaments, felts and aerogel opens up new strategies for the valorisation of the products.

[1] ENEA Patent - Galvagno, S.; P.; Portofino, S.; Lucchesi, A.; Corianò, O.A. Italian Patent RM2002A000217
[2] ENEA Patent - Galvagno, S.; Iovane, P.; Portofino, S.; Minarini, C.; Scafé, M. Italian Patent 10201900001164