Upcycling and reuse of prepreg waste

Italian research centre CETMA is exploring two ways to return uncured prepreg scrap into production.

Carbon fibre reinforced polymer (CFRP) use is rapidly increasing in a wide range of industrial sectors such as aerospace, automotive, marine, construction, renewable energy and others. The increasing use of CFRP creates a growing problem for waste disposal. Most of the research and industrial efforts have been directed towards the recycling of cured carbon fibre composites while less attention has been paid to the uncured scrap. Uncured prepreg scrap typically arises from two sources. The first is that generated during cutting operations. The second is out-of-spec material such as that beyond its out life or freezer life and this is often in the form of unopened or partially used prepreg rolls[1].

CETMA's commitment to solving the sustainability issues associated with prepreg scrap focuses on two main development routes:

1. Transformation of prepreg scraps into ready to use secondary raw materials (SRMs);
2. Extension of prepreg out life and shelf life.

Within the Italian project Ricreare (Recupero dI sCaRti aEronAutici nella prospettiva industRia 4.0 e sostEnibilità), CETMA aims to develop a prepreg production process, starting from uncured scrap resulting from cutting operations. After re-shaping the prepreg scraps into regular pieces, the scraps are superimposed in a controlled way and partially compressed to develop a continuous sheet of controlled thickness which is then rolled to form a new prepreg. This prepreg made from scraps could be used to produce composite products following the same production process of 'virgin' prepregs.

Prepreg scraps obtained from ply cutting operations.

Extending prepreg life

Regarding the out-of spec prepreg, CETMA is working on the development of a procedure to extend the useful life of prepregs. Research activities are performed within the project Plooto –Product Passport Through Twinning of Circular Value Chains, a European project that aims to develop a circular and resilient information system (CRIS) that enables waste reduction and end-to-end traceability of SRMs through interconnected digital services.

As is well known, thermoset prepregs undergo a progressive and irreversible cure reaction that alters the resin's physicochemical properties and its handling and processing behaviour. For prepregs beyond their out life and shelf life, as indicated by the manufacturer, the mechanical performance of composites are no longer assured. CETMA is developing a method to evaluate usability of out-of spec prepregs by finding a correlation between their thermal behaviour and the composite's mechanical performance. This correlation will be used as an instrument to recognise in an easy way, through simple experimental tests, the material's aging state.

At this point of the experimentation, we have proved that B-stage glass transition temperature (Tg0) and cure degree (α) are effective parameters to assess the aging process of expired prepregs and the relationship between the prepreg's thermal properties and composite's mechanical performance. Moreover, prepreg aging determines a reduction of the resin viscosity that can be managed by changing some processing parameters, such as process temperature, ramp rate or dwell time. Therefore, once the aging state of the material has been classified, new process parameters for composite production have been defined to extend the prepreg's useful life. Processing window modifications will restore the full value of expired prepregs ensuring that composite parts have similar performance to those obtained with not-expired prepregs.

Further information

- **CETMA: www.cetma.it**
- **Plooto project: www.plooto-project.eu**

References

1. G.N. & S. Nutt, Reuse and upcycling of aerospace prepreg scrap and waste, Reinforced Plastics, 2015.