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Thermoplastic nanofibers improve the mechanical performance of composites

Ghent University is seeking companies interested in commercializing the use of nanofibers in composite materials.

Nanofibers fabricated by electrospinning have been shown to drastically increase the fracture toughness of fiber reinforced thermosets, without negatively affecting other properties.

Applications

- Lightweight composite applications that require higher fracture toughness: wind turbine blades, airplane parts, front panels of trains, ….
- Sports: tennis rackets, fishing rods, …
- Local reinforcement on potential crack sites: riveted structures, …

Advantages

- Increase of the fracture toughness
- Easy incorporation into existing thermoset production such as infusion processes (RTM, VARTM) and autoclave processes (prepreg)
- Easy and perfect distribution of the *nano-reinforcement* in the composite contrary to nano-particles that are mixed in the resin.
- No significant weight added (1 – 20 g/m²)
- Other mechanical properties are not negatively influenced

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Production of nanofibers through electro-spinning

Nanofibers are obtained typically with diameters below 500 nm. Ghent University fabricates nanofibers through the process of electro-spinning which is depicted in the figure below

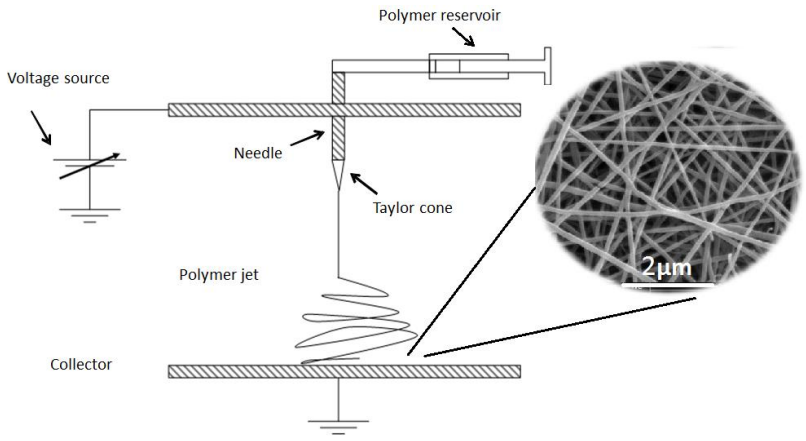

Fig. 1: Schematic overview of the electrospinning process used to make nanofiber nonwovens.

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Semi-industrial production facility

Ghent University currently has a semi-industrial production facility of nanofibers which allows to fabricate widths of up to 1 meter. To integrate the nanofibers into the composite the nanofibers can be spun directly onto glass or carbon fibers.

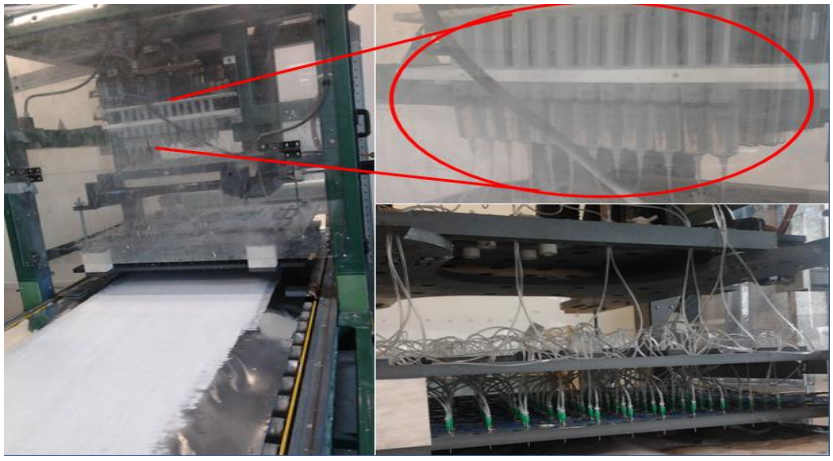

Fig. 2: Industrial electrospinning set-up at the Department of Textiles allowing for spinning nanofibers at industrial scale.

Thermoplastic nanofibers enhance the fracture toughness of glass fibre epoxy composites

By applying thermoplastic nanofibers in between the glass fiber layers over 90% improvement in fracture toughness could be achieved. This led to a mode I fracture toughness of over 1200 J/m2. Tensile and dynamic mechanical properties of the toughened laminates were not affected by the nanofibers. Furthermore, all experiments were done using state of the art infusion resins with a high intrinsic fracture toughness, showing that even these high end epoxy resins can benefit significantly from nanofibers toughening.

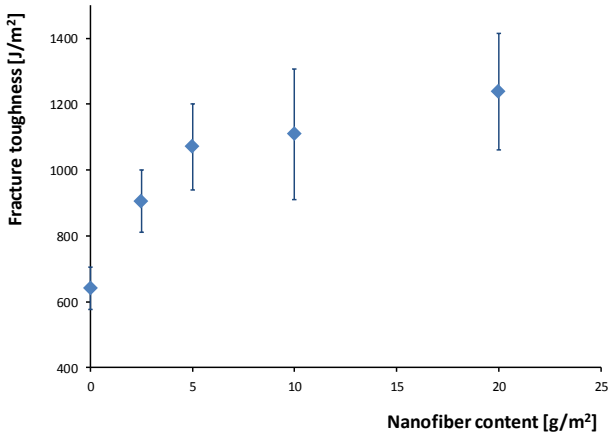

Fig. 3: Effect of nanofiber content on the interlaminar fracture toughness. The fracture toughness can be increased by 100% by adding a 20 g/m² nanofiber nonwoven in between neighboring plies.

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Fig. 4: Crack surface of nanofiber enhanced composites shows much more plastic deformation leading to an increased fracture toughness of the composite.

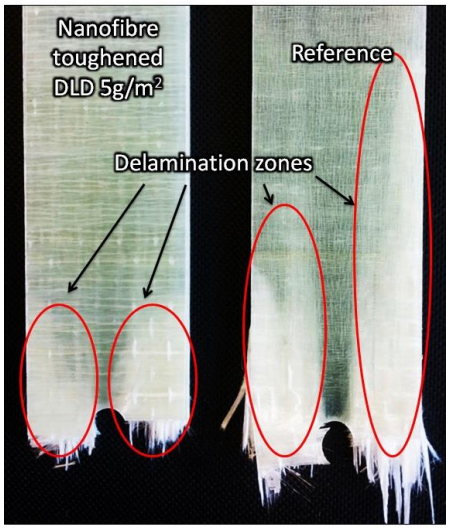

Fig. 5: Nanofibers stop delamination growth in composites, resulting in a much smaller damaged area.

Contact

Ilse Christiaens, PhD Technology Transfer Officer Technologiepark 903 9052 Zwijnaarde Belgium M: +32 487 46 97 78 T: +32 9 331 04 19 Ilse.Christiaens@UGent.be	**prof. Karen De Clerck** Department of Textiles Technologiepark 907 9052 Zwijnaarde Belgium Karen.DeClerck@UGent.be

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