Lightweight rotor blades made from plastic foams for offshore wind turbines

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Rotor blades made of thermoplastic sandwich materials. Credit: Fraunhofer ICT

Offshore wind turbines are becoming ever larger, and the transportation, installation, disassembly and disposal of their gigantic rotor blades are presenting operators with new challenges. Fraunhofer researchers have

partnered with industry experts to develop highly durable thermoplastic foams and composites that make the blades lighter and recyclable. Thanks to their special properties, the new materials are also suitable for other lightweight structures, for instance in the automotive sector. The first demonstrators will be on display at the K 2016 trade fair in Düsseldorf from October 19 to 26.

The trend toward ever larger offshore wind farms continues unabated. Wind turbines with rotor blades measuring up to 80 meters in length and a rotor diameter of over 160 meters are designed to maximize energy yields. Since the length of the blades is limited by their weight, it is essential to develop lightweight systems with high material strength. The lower weight makes the wind turbines easier to assemble and disassemble, and also improves their stability at sea. In the EU's WALiD (Wind Blade Using Cost-Effective Advanced Lightweight Design) project, scientists at the Fraunhofer Institute for Chemical Technology ICT in Pfinztal are working closely with ten industry and research partners on the lightweight design of rotor blades (see box). By improving the design and materials used, they hope to reduce the weight of the blades and thus increase their service life.

Thermoplastics are replacing thermoset-based materials

These days, rotor blades for wind turbines are largely made by hand from thermosetting resin systems. These, however, don't permit melting, and they aren't suitable for material recycling. At best, granulated thermoset plastic waste is recycled as filler in simple applications. "In the WALiD project, we're pursuing a completely new blade design. We're switching the material class and using thermoplastics in rotor blades for the first time. These are meltable plastics that we can process efficiently in automated production facilities," says Florian Rapp, the

project coordinator at Fraunhofer ICT. Their goal is to separate the glass and carbon fibers and to reuse the thermoplastic matrix material.

A model wind turbine with blades made from sandwich elements. Credit: Fraunhofer ICT

For the outer shell of the rotor blade, as well as for segments of the inner supporting structure, the project partners use sandwich materials made from thermoplastic foams and fiber-reinforced plastics. In general, carbon-fiber-reinforced thermoplastics are used for the areas of the rotor blade that bear the greatest load, while glass fibers reinforce the less stressed areas. For the sandwich core, Rapp and his team are developing thermoplastic foams that are bonded with cover layers made of fiber-reinforced thermoplastics in sandwich design. This combination improves the mechanical strength, efficiency, durability and longevity of the rotor blade. "We're breaking new ground with our thermoplastic foams," says Rapp.

Lightweight construction material for new applications

The ICT foams provide better properties than existing material systems, thus enabling completely new applications – for instance in the automotive, aviation and shipping industries. In vehicles, manufacturers have been using foam materials in visors and seating, for example, but not for load-bearing structures. The current foams have some limitations, for instance with regard to temperature stability, so they can't be installed as insulation near the engine. "Our meltable plastic foams, by contrast, are temperature stable and therefore suitable as insulation material in areas close to the engine. They can permanently withstand higher temperatures than, for example, expanded polystyrene foam (EPS) or expanded polypropylene (EPP). Their enhanced mechanical

properties also make them conceivable for use in door modules or as stiffening elements in the sandwich composite," reports Rapp. They can be processed quickly and they save material. Yet another advantage is that thermoplastic foams are more easily available than renewable sandwich core materials such as balsa wood. These innovative materials are manufactured in the institute's own foam extrusion plant in Pfinztal. Rapp explains the process: "We melt the plastic granules, mix a blowing agent into the polymer melt and foam the material. The foamed, stabilized particles and semi-finished products can then be shaped and cut as desired." In the area of foamed polymers, the ICT foam technologies research group covers the entire thermoplastic foams production chain, from material development and manufacture of extrusion-foamed particles and semi-finished products to process media and finished components.

Thermoplastic tapes with different fiber matrix combinations. Credit: Fraunhofer ICT

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