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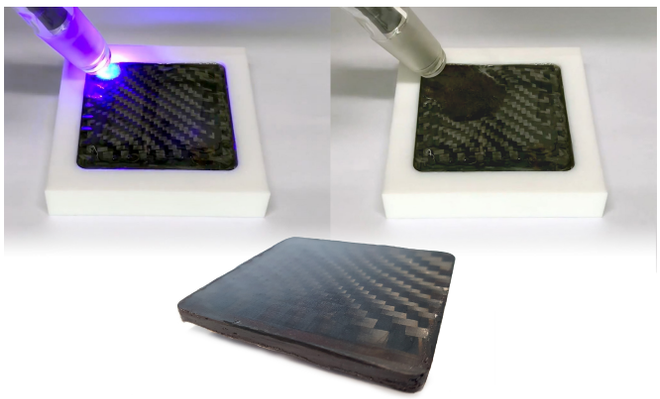
Epoxy resin with on-demand curing triggered by a spotlight

Environmentally friendly, quick, economic, efficient – for any complex structure and shape – even under water

Epoxy resins are one of the most important classes of plastics for a variety of applications, such as for fiber and particle composites in the automotive, shipbuilding and aircraft industries or for coatings, adhesives, casting compounds in the electronics industry.

The global epoxy resin market is growing steadily and at present amounts to a market volume of more than $20 billion a year. Until now, epoxy resins have been cured by means of special hardeners, some of which are toxicologically questionable. These two-component systems have very limited storage stability; and they require very time, energy and cost-consuming curing methods.



Curing of a carbon fiber composite by a short UV pulse

Objectives

Overcoming these limitations in industrial applications and developing a new energy- and time-efficient curing procedure was the aim of Prof. Dr. Robert Liska in the Research Unit Macromolecular Chemistry at TU Wien. The main focus was on light-based systems – or photopolymerization. Since such systems are very energy-efficient, there was hope that they could eliminate the use of environmentally harmful solvents. Specifically, a new epoxy resin system was to be developed that shows a high storage stability and would cure quickly upon a short impulse – by itself so to speak – and without additional energy input.

Solution: frontal polymerisation

TU Wien succeeded in developing a completely new technology for the curing of epoxy resins: frontal polymerization. The curing of the material may be triggered “on demand” by a local light or temperature impulse. After a short exposure, the curing front propagates through the entire workpiece without any further input of energy, even hard-to-reach areas are cured.

This technology now enables the production of one-component formulations for time- and energy-efficient curing that are easy to handle and show a high storage stability.

Results

Frontal polymerization enables a completely new curing technology for epoxy resins. Up to now, conventional curing often required large industrial furnaces and autoclaves or environmentally hazardous reagents. Now the user may save all of these energy, time and cost-intensive aids.

The material properties obtained with the new method are equal to or even superior to those of conventionally cured epoxy resin polymers: modulus of elasticity 3800 MPa, tensile strength 64 MPa, impact strength 10.64 kJ/m², glass transition temperature 160 °C.

Due to their chemical structure, the materials are stable to hydrolytic or oxidative degradation, which represents a novelty in the field of epoxy resins. In contrast to conventional systems, the newly developed formulations show a storage stability of many years, even though they are one-component systems.

Conventional two-component systems must be mixed in an additional step on site and then have a processability of only a few minutes or hours.

Test applications impressively demonstrated that this new technology enables, among others, the production of highly filled fiber composites. These are for instance widely used in the automotive and aircraft industry.

These resins of TU Wien can also cure under water. This opens up completely new applications in the shipbuilding industry as well as for bridge and dam rehabilitation.

The CURRATEC project team at TU Wien works closely with interested industrial companies to adapt the new resin system optimally to their individual requirements.

Particle filled composite materials

Thanks to the support of the Austrian Research Promotion Agency (FFG), this technology can be developed for market introduction and launched on the market by a start-up company.

Applications

- fiber and particle composites
- molded parts
- crack fillings
- adhesives
- impregnating resins
- casting compounds
- in any, even complex structures
- may also be used under water

For the automotive industry, aerospace, building and construction, plastics technology, composites, shipbuilding, high-tech sports equipment, electrical and electronics industries

Benefits for you

- saves time and costs
- one-component system with high storage stability
- simple and flexible processing
- very good mechanical properties of cured components
- production of highly filled composite materials
- environmentally friendly, no risks for health or climate
- enables underwater curing

Notes

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