



TUfast e.V. is a student association at the Technical University of Munich. The association builds its own cars and has enjoyed regular success in race series such as Formula Student or Shell Eco-Marathon. The CFRP body parts undergo curing in a Memmert heating oven in a vacuum under heat.

In theory, the eLi14 electric car built by students at the Technical University of Munich can travel 10,957.02 km on the equivalent energy of a single litre of premium-grade petrol. This achievement earned the students both a world record for the most energy-efficient car and an entry in the Guinness Book of Records. The lightweight single-seater weighs just 20 kg, has a carbon fibre reinforced polymer (CFRP) body, and is powered by an electric motor fed by lithium polymer batteries.



Memmert drying oven

Playing with cars at the Technical University of Munich: TUfast e.V.

Vehicles like the eLI14 are planned, designed, and built by teams of student across the whole world, who are given complete independence. Because practical experience is important, and Goethe was on to something all those years ago when he said “All theory is grey”. It would be wrong to regard these vehicles as toys as they also provide a source of inspiration for future developments in the automotive industry. During international efficiency competitions such as the Shell Eco-Marathon, future engineers from around the world come together to see how their self-developed vehicles fare against each other.

More than 15 years ago, the student association known as TUfast e.V. was founded at the Technical University of Munich and committed itself entirely, with support from sponsors, to building vehicles for competition. More than 100 students regularly devote large chunks of their spare time to working on one of these innovative vehicles. There is an Eco Team and also a Racing Team, which takes part in the Formula Student series of international races. This competition provides an opportunity to assess both a vehicle's speed and also its design across the three separate categories of combustion engines, electric motors, and autonomous vehicles.

Lightweight components made of CFRP

Weight is an important factor in both the speed and energy efficiency of a vehicle, which means lightweight fibre composites (made from synthetic substances) are the perfect material for body parts in the racing cars built by the students. Reinforced synthetic fibres or mesh are inseparably combined with a matrix material, which fills the spaces in between, to create a thermosetting plastic that cannot be manipulated any further. Synthetic resins such as epoxy resin are often used for the matrix material.

During the so-called prepreg process, the fibre composite is pre-impregnated with a reaction resin and can be placed in the mould as a kind of outline. At this stage, the epoxy resin is slightly tacky but not fluid. After moulding, the parts are cured in a vacuum under heat. At the TUfast laboratory, the moulded prepreg parts made of carbon fibre reinforced polymer (CFRP) are cured in a Memmert heating oven. The

parts come in a vacuum-sealed bag, which is vented using an external vacuum pump. The tubing for the vacuum pump is fed into the heating oven through an entry port. The curing process generally lasts 3 hours and mostly happens at a temperature of 120 °C. During the first phase, the epoxy resin becomes fluid, which enables it to completely penetrate the microfibrils in the CFRP mesh. Any air bubbles are forced out and sucked away via the vacuum pump. During the rest of the curing period, the epoxy resin reacts with the epoxy curing agent and the part's shape becomes stable.

Precise temperature in the heating oven

It is crucial to set and maintain a precise temperature in the heating oven during the entire curing process. This promotes thorough chemical cross-linking in the components and therefore ensures that parts made from carbon fibre reinforced polymer (CFRP) are of the requisite quality. Some processes require temperature ramps, and the students at TUfast e.V. are really pleased to have the option of programming ramps both quickly and easily for their heating oven. Another application for the Memmert heating oven is the tempering of adhesive bonds. AtmoSAFE would like to thank TUfast e.V. for its friendly support in writing this article.

Overview of the main topics

- TUfast, Formula Student, Technical University of Munich
- Prepreg, carbon prepreg
- Fibre composites
- Curing epoxy resin
- Carbon fibre reinforced polymer (CFRP)
- Vacuum film, vacuum-sealed bag, vacuum pump
- Memmert, heating oven

Degassing in a vacuum

The Swiss company Microdul AG uses a Memmert vacuum oven VO for degassing epoxy resin during the manufacture of electronic modules.

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[Cooled vacuum oven VOcool](#)

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