

Determination of the material properties of polymers, composites and bonded joints at cryogenic temperatures

Cover picture: Temperature-controlled tensile tests in the temperature range between $-196\text{ }^{\circ}\text{C}$ and $200\text{ }^{\circ}\text{C}$ with local strain measurement.

Depending on the application, components and materials must be resilient, leak-proof and safe even at cryogenic temperatures. Examples include liquid gas tanks and tank feed lines, which are often made of fiber-reinforced plastics (FRP) or contain FRP in combination with metallic materials. Such tanks are used, for example, in areas such as aerospace and renewable energy.

Low temperatures not only change the load-bearing capacity of the materials, but also generate special load conditions at joints between different types of materials. In order to safely design tank structures with their feed lines and joints for the application, it is important to understand these relationships. It is therefore necessary to test the static, dynamic, and fracture mechanical behavior of materials at cryogenic temperatures. The focus of cryogenic testing at Fraunhofer IFAM is on polymers, composites, and bonded joints.



A cryogenic testing machine is available at Fraunhofer IFAM for the tests. This has a special set-up which allows material testing in a cryogenic tank with liquid nitrogen at $-196\text{ }^{\circ}\text{C}$ and in a temperature chamber for temperature-controlled tests in a temperature range between $-170\text{ }^{\circ}\text{C}$ and $200\text{ }^{\circ}\text{C}$. This setup represents an extension of the static and dynamic testing machines established at the institute for materials testing of polymers, adhesives, bonded joints and fiber composites for application-related issues. The institute's researchers have outstanding expertise and a wealth of experience in testing at temperatures from $-50\text{ }^{\circ}\text{C}$ to $200\text{ }^{\circ}\text{C}$, which they have now extended into the cryogenic temperature range.

Left picture: Test setup with temperature chamber for material testing of polymers, adhesives, adhesive joints, and fiber composites at cryogenic temperatures as low as $-170\text{ }^{\circ}\text{C}$.

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