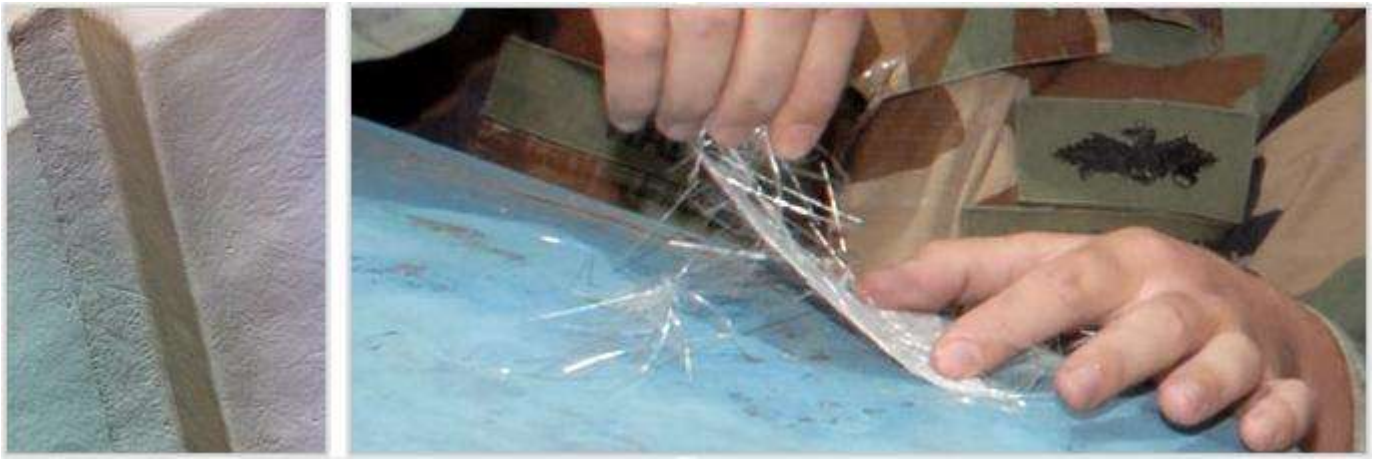
Description

Image



Caption

1. Close-up of the back of the material. © Salawraspoo at en.wikipedia - (CC BY-SA 3.0) 2. Equipment operator demonstrates fiber glass repair techniques, repairing damage on a small boat. © U.S. Navy - Public domain

The material

Composites are one of the great material developments of the 20th century. Those with the highest stiffness and strength are made of continuous fibers (glass, carbon or Kevlar, an aramid) embedded in a thermosetting resin (polyester or epoxy). The fibers carry the mechanical loads, while the matrix material transmits loads to the fibers and provides ductility and toughness as well as protecting the fibers from damage caused by handling or the environment. It is the matrix material that limits the service temperature and processing conditions. Polyester-glass composites (GFRPs) are the cheapest and by far the most widely used. A recent innovation is the use of thermoplastics as the matrix material, either in the form of a co-weave of cheap polypropylene and glass fibers that is thermoformed, melting the PP, or as expensive high-temperature thermoplastic resins such as PEEK that allow composites with higher temperature and impact resistance. High performance GFRP uses continuous fibers. Those with chopped glass fibers are cheaper and are used in far larger quantities. GFRP products range from tiny electronic circuit boards to large boat hulls, body and interior panels of cars, household appliances, furniture and fittings.

Composition (summary)

Epoxy + continuous E-glass fiber reinforcement (0, +-45, 90), quasi-isotropic layup.

General properties

Density	1.75e3	-	1.97e3	kg/m^3
Price	* 25.3	-	27.9	GBP/kg

Mechanical properties

Young's modulus	* 21	-	21.8	GPa
Yield strength (elastic limit)	* 207	-	304	MPa
Tensile strength	* 207	-	304	MPa
Elongation	* 0.85	-	0.95	% strain
Hardness - Vickers	* 10.8	-	21.5	HV
Fatigue strength at 10^7 cycles	* 41.3	-	91.1	MPa
Fracture toughness	* 19.3	-	31	MPa.m^0.5

Thermal properties

Maximum service temperature	* 140	-	220	°C
Thermal conductor or insulator?	Poor insulator			

Thermal conductivity	*	0.42	-	0.51	W/m.°C
Specific heat capacity	*	1.02e3	-	1.12e3	J/kg.°C
Thermal expansion coefficient	*	8.64	-	33	µstrain/°C

Electrical properties

Electrical conductor or insulator?	Good insulator

Optical properties

Transparency	Translucent

Eco properties

Embodied energy, primary production	*	95.7	-	106	MJ/kg
CO2 footprint, primary production	*	5.73	-	6.32	kg/kg
Recycle	✖				

Supporting information

Typical uses

Sports equipment such as skis, racquets, skate boards, golf club shafts, ship and boat hulls, body shells, automobile components, cladding and fittings in construction, chemical plants.

Links

ProcessUniverse