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Sophisticated Glass Tapes for Fabrication of Composites ⋆

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Abstract

The mechanical properties of fabrics derived from glass tows are excellent. They can be used for reinforcement of composites. In this work, glass fiber based stabilized hybrid composite tapes (SHCT) containing special types of resins which could be used for preparation of composites using precise winding technique was prepared. The resins were loaded by suitable types of nanoparticles that would enhance mechanical properties. Detailed investigation of tensile forces like breaking force, deformation at break and initial modulus was conducted. The results showed a significant difference between the samples. This research achieved loading of resins without its penetration into the winded structure through tight and complicated arrangement of fibrous phase. The tapes were found to be durable that enables their long-term storage and their sustained fit-to-use after extended storage times.

Keywords: Hybrid Tapes; Tensile Properties; Precise Winding; Composites; Epoxy Resin

1 Introduction

The properties that glass fibers exhibit are their nonflammability, strength, abrasion resistance, cost effective processing and reasonable price. This makes them excellent candidates for Textile applications. Some of the disadvantages are sensitivity to strong alkalis, surface corrosion, fragility and relatively hard processability [1-7]. These fabrics are produced using multifilament yarns. The compactness and improvement of strength and evenness is achieved by gluing them together (roving yarn) into tape shapes (tows) [8, 9]. Composites are made of multifilaments. Low bending

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stiffness is maintained by a combination of filaments of low fineness below 10 μm diameter. The cross-sectional fibers may range from anything between 1 000 to 24 000. The circular cross-section and density are directly proportional to number of twists and inversely proportional to the initial modulus and yarn strength. Due to the increased density, resin does not penetrate easily. Prepregs can be manufactured using rovings with twists of less than 50 curls/m which have an oval cross section and decreasing porosity from edge to the centers. Spread tow tapes width may be up to 3 times the diameter of the original multifilament. When the individual filaments are very closely arranged, they behave like a bunch of identical long parallel threads. This arrangement leverages the strength of individual filaments and influences the thickness and density [10-13]. However, cohesion and resin saturation are affected by long storage. Composite materials' mechanical properties are sometimes compromised due to usage of roving affected by uneven disconnection of fibers under high speeds of production and spinning. Due to this reason, only a percentage of fibers can be completely turned off during the preparation of the prepreg when the composite is loaded. This paper deals with the preparation of stabilized hybrid composite tapes (SHCT) with an optimally arranged resin-bonded fibrous phase and surface nanoparticles with which composites can be made by precision robotic winding. The mechanical properties (breaking force, deformation at break, initial modulus) of stabilized hybrid composite tapes (SHCT) was studied.

2 Materials and Method

The stabilized hybrid composite tape SHCT (Fig. 1) consists an expanded tape of a glass uncoated multifilament cable (E-glass 1 310 fibers) parallelized to the direction of the belt axis. The strength of the epoxy-free tape (sample 1) was 285.6 N (s*=14.61), the strength of the fibers was 30.65 cN (s*=2.09) and the number of fibers in the tape were estimated as 922. The parameters of the fibres are provided in Table 1.

Table 1: Fibre Parameters

Parameter	Confidence Interval (C.I)*	Lower Limit (LL)*	Upper Limit (UL)*
Fineness (dtex)	3.16	2.60	3.72
Strength (cN)	30.64	26.29	35.0
Deformation at break (%)	6.72	6.07	7.35
Initial modulus (GPa)	26.12	17.30	34.95

Special catalysts in Epoxy type resins extends storage duration and subsequent heat curing. Grinding activated fumed F-type fly ash supplied by SILO, Pilsen Czech Republic, at 3% concentration and mechanically activated by Fritsch pulversisette 7 planetary ball mill, was found to improve most of the mechanical properties of the matrix. Glass filaments of 600 Tex, thickness of 2.15 mm and of a fiber content of 0.34 were used as textile reinforcement. CHS-EPOXY 200 V with a catalyst were purchased from Spolchemie and Chemex, Czech Republic and the mixing ratio was 100:27 by weight. First, hardener was mixed with fillers, and then the resultant solution was mixed with epoxy by using a magnetic stirrer for 5 minutes. A homogenous mixture was obtained by mixing fly ash particles with epoxy resin at room temperature. The composite was cured in an oven at 120 °C and 50 kPa for 30 minutes. The samples are described in Table 2.