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Time Temperature Dependence of Long Fiber Reinforced Polypropylene Manufactured by Direct Long Fiber Thermoplastic Process

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Abstract : In order to reduce fuel consumption, the weight of automobiles has to be reduced. Fiber reinforced polymers offer the potential to reach this aim because of their high stiffness to weight ratio. Additionally, the use of fiber reinforced polymers in automotive applications has to allow for an economic large-scale production. In this regard, long fiber reinforced thermoplastics made by direct processing offer both mechanical performance and processability in injection moulding and compression moulding. The work presented in this contribution deals with long glass fiber reinforced polypropylene directly processed in compression moulding (D-LFT). For the use in automotive applications both the temperature and the time dependency of the materials properties have to be investigated to fulfill performance requirements during crash or the demands of service temperatures ranging from -40 °C to 80 °C. To consider both the influence of temperature and time, quasistatic tensile tests have been carried out at different temperatures. These tests have been complemented by high speed tensile tests at different strain rates. As expected, the increase in strain rate results in an increase of the elastic modulus which correlates to an increase of the stiffness with decreasing service temperature. The results are in good accordance with results determined by dynamic mechanical analysis within the range of 0.1 to 100 Hz. The experimental results from different testing methods were grouped and interpreted by using different time temperature shift approaches. In this regard, Williams-Landel-Ferry and Arrhenius approach based on kinetics have been used. As the theoretical shift factor follows an arctan function, an empirical approach was also taken into consideration. It could be shown that this approach describes best the time and temperature superposition for glass fiber reinforced polypropylene manufactured by D-LFT processing.

Keywords : composite, dynamic mechanical analysis, long fibre reinforced thermoplastics, mechanical properties, time temperature superposition
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