3 - 7 JULY 2023
HERAKLION, CRETE | GREECE
ACEX2023
16th International Conference on Advanced Computational Engineering and Experimenting

ABSTRACT:

Multiphysics Simulation and Optimization of the Curing Process of Thick Thermosetting Epoxy Samples: Multi-Objective Genetic Algorithm and Conversion Rate Driven Strategies

L.F.C. Pereira1, N. Bouchonneau1, C. Jochum2

1Federal University of Pernambuco, Recife, Brazil
2ENSTA Bretagne - IRDL-UMR CNRS 6027, Brest, France

Over the last decades thermoset resin composite materials have been replacing conventional materials in several high performance engineering applications. These composites are usually produced in an autoclave by carrying out a cure schedule. However, for the case of thick thermosets, the manufacturer's recommended cure (MRC) schedule usually results in cures either that are unnecessarily too long or that overheat the material internally, due to the thermoactived and exothermic aspects of the curing reaction associated to the thermal insulating property of the thermoset [1]. This local overheating results in high gradients in the thermoset properties that may create residual stresses and structural defects, such as bubbles and cracks. To avoid this and find optimal cure schedules, this work simulated the cure process of a thermoset using the finite element software COMSOL Multiphysics and implemented two optimization methods in MATLAB. The first method is an authorial conversion rate driven (CRD) strategy based on cure kinetics, which has a single objective: minimize the cure time. The second one is a multi-objective genetic algorithm (GA) with three conflicting objectives: minimize cure time, minimize the gradient of degree of cure after gel point (AGP) and minimize the gradient of temperature AGP, reflecting the existing trade-off between manufacturing speed and product quality. Results show that, in comparison to the MRC schedule, the CRD strategy and GA reduced the cure time by almost the same amount: 87% and 88%, respectively; whereas the gradients of degree of cure and temperature AGP were reduced by the GA by 6% and 31%, respectively. As a consequence, the methods presented in this work were shown to be effective tools to optimize the cure schedule of thermosets.

[1] N. Rabearison, C. Jochum and J.C. Grandidier, Computational Materials Sciences, 45, 715 (2009).