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Multi response optimisation of Mechanical properties in Self-healing Glass Fiber Reinforced Plastic using Grey Relational Analysis

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Abstract

Self-healing composites belong to the class of advanced materials, where the autonomic Self-healing is achieved when a microcrack propagates through the material which triggers the healing mechanism. Microcapsules filled with healing agent were mixed with epoxy resin and reinforced with glass fiber mats to make the Self-healing GFRP composite. The aim of this paper is to study the effect of various parameters- microcapsule size, concentration and catalyst concentration on the basic mechanical properties-Tensile strength, Compressive strength and Flexural strength of the material and to find the best possible combination of parameters to optimise the mechanical properties. Taguchi Design of Experiments was adopted to conduct the experiments by varying the levels of input parameters and the output responses were recorded and converted to a single grey scale to get the optimal combination. The goodness of data was validated through ANOVA. It was found that lesser microcapsule size and concentration with medium catalyst concentration gave better mechanical properties.

Keywords: Self-healing composites, Glass fiber reinforced plastic, Multiresponse optimisation, Mechanical properties, Grey relational analysis

1. Introduction

Composite materials are tailor made to suit different functional requirements for any application. Self-healing composite materials were proposed to perform the function of crack healing, as crack when propagated leads to unpredictable and disastrous failure of the material. The potential of healing in every living organism has been the source of inspiration behind the invention of these kind of special functional materials [1]. Over the decade, Self-healing mechanisms have been explored and researched in a variety of dimensions, viz the method of triggering the healing process (autonomic, non-autonomic [2]), healing in different base materials (polymers[3-7], concrete[8] etc.,), different ways of storing the healing agent (microcapsules,[3] hollow fibers [1], vascular network[4] etc.,), types of healing agents (Dicyclopentadiene[5], Polydimethylsiloxane[6], epoxy[9] etc.). The microencapsulation approach of Self-healing has yielded the highest healing efficiency compared to other healing agent delivery mechanisms [7]. The autonomic Self-healing was demonstrated by measuring the static fracture toughness by inducing crack in the material [2,5]. The fatigue crack propagation studies were done through cyclic loading in Self-healing composites [10,11]. The effect of microcapsule size and concentration, catalyst size and