Fabrication and Testing Of SMA Composite Beam with Shape Control

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Abstract. Smart materials are the advanced materials that have characteristics of sensing and actuation in response to the external stimuli like pressure, heat or electric charge etc. These materials can be integrated in to any structure to make it smart. From the different types of smart materials available, Shape Memory Alloy (SMA) is found to be more useful in designing new applications, which can offer more actuating speed, reduce the overall weight of the structure. The unique property of SMA is the ability to remember and recover from large strains of upto 8% without permanent deformation. Embedding the SMA wire/sheet in fiber-epoxy/flexible resin systems has many potential applications in Aerospace, Automobile, Medical, Robotics and various other fields. In this work the design, fabrication, and testing of smart SMA composite beam has been carried out. Two types of epoxy based resin systems namely LY 5210 resin system and EPOLAM 2063 resin system are used in fabricating the SMA composite specimens. An appropriate mould is designed and fabricated to retain the pre-strain of SMA wire during high temperature post curing of composite specimens. The specimens are fabricated using vacuum bag technique.

INTRODUCTION

Shape Memory Alloy (SMA) is a novel metal alloy, which has the ability to return to a memorized shape when heated. A shape memory alloy is also known as a smart alloy, memory metal, or muscle wire. The unique property of SMA is the ability to remember and recover from large strains of up to 8% without permanent deformation unlike most conventional metals that recover less than 1% strain before plastic deformation. This occurs due to temperature dependent phase known as martensitic phase, which occurs at lower temperature and austenitic phase which occurs at higher temperature [1, 2].

Shape Memory Polymers (SMPs) are polymeric smart materials that have the ability to return from a deformed state (temporary shape) to their original (permanent) shape induced by an external stimulus (trigger), such as temperature change. Glass Transition temperature (Tg), is the temperature below which molecules have little relative mobility and are in a glassy state. Tg is usually applicable to amorphous phases. Above the Tg, secondary bonds between the polymer chains become weak in comparison to thermal motion, and the polymer becomes rubbery [3, 4, 5].

As composite structures are replacing the metallic one in recent days due to their high strength and stiffness to weight ratios which are the prime requirements of aerospace structures. People through the globe have been working with characterization of various composites. Veeresh Kumar G B et al. [6] have attempted the wear characterization of aluminum metal matrix composites. The smart material which is used as an actuator can be easily embedded into the composites possible due to the kind of fabrication process involved. In that view, composite structure containing shape memory alloy show great promise in applications such as vibration suppression of aircraft structures, morphing and shape control of aerospace structures, improved damping for better aero elastic performance of aircraft lifting components and improved seismic properties of civil structures [7, 8, 9, 10]. In the present study SMA wires embedded in continuous fiber –epoxy composites is attempted. In continuous fiber composites, Ni-Ti SMA is considered with glass fabric and the high temperature resin system LY5210 is used as the matrix material.

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