Fabrication and properties of shape-memory polymer coated with conductive nanofiber paper

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ABSTRACT

A unique concept of shape-memory polymer (SMP) nanocomposites making up of carbon nanofiber paper was explored. The essential element of this method was to design and fabricate nanopaper with well-controlled and optimized network structure of carbon nanofibers. In this study, carbon nanofiber paper was prepared under ultrasonicated processing and vapor press method, while the dispersion of nanofiber was treated by BYK-191 dispersant. The morphologies of carbon nanofibers within the paper were characterized with scanning electron microscopy (SEM). In addition, the thermomechanical properties of SMP coated with carbon nanofiber paper were measured by the dynamic mechanical thermal analysis (DMTA). It was found that the glass transition temperature and thermomechanical properties of nanocomposites were strongly determined by the dispersion of polymer in conductive paper. Subsequently, the electrical conductivity of conductive paper and nanocomposites were measured, respectively. And experimental results revealed that the conductive properties of nanocomposites were significantly improved by carbon nanopaper, resulting in actuation driven by electrical resistive heating.

Keywords: Carbon nanofiber, nanocomposite, nanopaper, shape-memory polymer

1. INTRODUCTION

In recent years, the development of shape memory polymers (SMPs) have grown rapidly due to their outstanding advantages, as structural versatility, low manufacturing cost, easiness in processing, high elastic deformation (strain up to more than 100%), and tailored recovery temperature [1-3]. These unique characteristics lend them to be used in a myriad of fields, including clothing manufacturing, automobile engineering, aerospace engineering, medical treatment, and many other applications [3-6]. SMPs are classified as thermal responsive intelligent material that can be undergone large deformation upon heated above the special transition temperature of polymer. This deformed or temporary shape can be kept when the polymer is cooled down below the transition temperature. And then, SMPs are relaxed to its original, permanent shape again via external heating. Similar with other types of shape memory materials, with application domain of SMPs growing explored, actuation of shape recovery is seriously limited by traditional direct heating approach. Fortunately, many interesting and valuable researches have been done on the actuation for SMPs or SMP composites, of which shape recovery can not only be induced by external stimuli such as heating, but can be manipulated via light [5-6], water [7], electricity [8-12], magnetic field [13-14] or solvent. However, for the electrical or magnetic resistive heating SMP composite, almost all previous works are focused on blending functional filler into...