Fabrication and properties of thermoresponsive materials: experimental and computational studies

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Abstract

Stimuli-responsive materials can undergo relatively large and abrupt, physical or chemical changes in response to external changes in environmental conditions. This characteristic originates from their responsive behavior against slight stimuli in the surrounding environment. These smart materials can recognize a stimulus as a signal, judge the magnitude of that, then change their configuration in direct response. The stimuli can be classified into chemical (pH change, salt concentration), physical (temperature, pressure, electric/magnetic field, and mechanical (stress). Thermo-responsive materials are able to demonstrate change in properties/function as a result of temperature change. They have been the focus of many researches as well as industrial applications, mainly because of the ease in activation during application.

In this talk, research results on two groups of thermo-responsive materials are discussed. In the first part, our experimental findings on high temperature shape memory alloys (HTSMAs) will be presented. This part will cover significant results on these materials with respect to their fabrication, mechanical treatment, and aging heat treatment. In particular, aging treatment is shown to be an efficient method for enhancing transition temperatures and shape memory properties. In the second part, molecular simulations of thermo-responsive polymer-graphene hybrid systems will be discussed. Using large-scale simulations, formation and stimuli-responsive properties of these systems are explained from an atomistic point of view. More specifically, the rationale behind shift in transition temperature, which occurs in hybrid systems, is elucidated in terms of interactions and solvation behavior.

Recent Publications

1. Moshref-Javadi M, Simon G, Medhekar N, Atomistic Insights into the Adsorption and Stimuli-Responsive Behavior of Polymer-Graphene Hybrid Systems, *Unpublished results*.
2. Askariani SA, Pishbin H, Moshref-Javadi M (2017) Effect of Welding Parameters on the Microstructure and Mechanical Properties of the Friction Stir Welded Joints of a Mg-12Li-1Al Alloy, *Journal of Alloys and Compounds*, 724:859–868.
3. Moshref-Javadi M, Belbasi M, Seyedein SH, Salehi MT (2014) Fabrication of (Ti,Hf)-Rich NiTiHf Alloy Using Graphitic Mold and Crucible, *Journal of Materials Science and Technology*, 30:280–284.
4. Moshref-Javadi M, Seyedein SH, Salehi MT, Aboutalebi MR (2013) Aged-Induced Multi-Stage Transformation in a Ni-rich NiTiHf, Acta Materialia, 61:2583–2594.
5. Moshref-Javadi M, Belbasi M, Salehi MT, Afshar MR (2011) Effect of Aging on the Microstructure and Shape Memory Effect of a Hot-rolled NiTiHf Alloy, *Journal of Materials Engineering and Performance*, 20:618–622.

Biography of Dr. Mahdi Moshref-Javadi

Dr. Mahdi Moshref-Javadi is a researcher at RMIT and Monash University. He achieved his PhD degree in Materials Science and Engineering from Monash University (Australia). His main area of research is smart materials, including both experimental and simulation studies. Recently, he has worked on molecular simulations of complex stimuli-responsive polymer-graphene hybrid system. Previously, he worked experimentally on shape memory alloys with the focus on improving their fabrication process and shape memory properties. His researches also expand to friction stir processing as well as molecular simulation of porous materials for gas adsorption.

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