Proceedings of the 9th Biennial ASME Conference on Engineering Systems Design and Analysis
ESDA08
July 7-9, 2008, Haifa, Israel

ESDA2008-59031

Work Output Enhancement of Ferromagnetic Shape Memory Micro Actuators

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ABSTRACT

Ferromagnetic shape memory (*FSM*) alloys are a class of materials which are both ferromagnetic and capable of undergoing a structural phase transformation. *FSM* alloys have significant advantage over conventional shape-memory temperature-based actuators because they can be remotly actuated by fast alternating magnetic fields. Therefore, *FSM* alloys attract keen attention as promising candidates for a variety of *MEMS* applications, as they can provide large strokes using small components. The most commonly used FSM alloy is Ni_2MnGa and its off-stoichiometric alloys, which are used in commercial *cm-scale FSM* actuator. However, at the current stage, no experiments of the magneto-mechnical behavior of *micro-scale* actuators were conducted.

Overall, the behavior of FSM alloys involves motion of twin boundaries and is significantly influenced by its microstructure. Based on a theoretical model, we have shown that down-scale specimens have finer twin boundary microstructure that consequently may increase the blocking stress characteristic such that it will enhance the output work for actuation. In light of this, a novel experimental method was realized to establish this conjecture and to provide comprehensive information on the behavior of small actuators. A series of tests demonstrated no actuation strain reduction up to extraordinary loads of 10MPa, and thus paves the route for engineering FSM high-power micro actuators by controlling their microstructure.