Optimization of Shape Memory Alloys for Use in Electrical Connectors

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ABSTRACT

In an effort to reduce costs associated with automotive electrical connectors, auto manufacturers have looked to tin-coated terminals as an effective alternative to more expensive gold-coated terminals. Tin, however, is highly subject to a wear phenomenon known as fretting corrosion, which increases the contact resistance and renders the terminals useless. One solution to minimize fretting corrosion is to increase the terminal normal force. In ordinary electrical terminals, an increased normal force leads to other problems such as high insertion and removal forces. This work is a continuation of previous research in which a Ni-Ti shape memory alloy (SMA) coil was developed in order to increase the high temperature normal force of tin-coated terminals while maintaining moderate room temperature insertion forces. In particular, this work addresses the cyclic stability of the SMA coil when subjected to repeated temperature cycles over extended periods, the maximization of normal force provided by the coil for the amount of SMA used, and the long-term high-temperature performance of the SMA. This research has resulted in the reduction of the SMA wire diameter by nearly 30%, an increase in high temperature removal force of the terminal from approximately 20 N without the SMA to 60 N with it, and an associated reduction in cost by nearly 50% over the previous design. To accomplish these improvements, the SMA composition was changed from 55.1 wt% Ni to 49.7 wt% Ni, and the optimum training temperature for the new composition was found to be 400 $^{\circ}$C.