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Shape Memory Ceramics and Their Application to Latching Relays

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Basic characteristics of shape memory unimorphs have been measured in detail, and a new latching relay has been fabricated using the shape memory unimorph. This new relay has a very simple structure with compact size and light weight, as compared with the conventional electromagnetic type. The relay is turned ON at 350 V and turned OFF at −50 V with a short-pulse electric field. The response time is about 13 ms under an input electric energy of 7 mJ. The relay can be kept in an ON state for more than a day without applying any electric field.

1. Introduction

The shape memory effect is not only characteristic of certain metal alloys, but is also observed in ceramics. Figure 1 shows the transverse strains induced in the ceramic plates of $Pb_{0.99}Nb_{0.02}[(Zr_{0.6}Sn_{0.4})_{1-y}Ti_y]_{0.98}O_3$ (PNZST) under an applied electric field.[1-3] These strain curves can be classified into three patterns with changing Ti mole fraction.

The ceramic of Type I ($y = 0.060$) is originally antiferroelectric, but can be changed to ferroelectric by applying an electric field, and large strains are generated during the phase transition. It is worth noting that the magnitude of strain is three to four times as large as that of the conventional piezoelectrics. When the electric field is decreased, the phase of the ceramic is changed back to the initial antiferroelectric and the strain recovers. The square-type hysteresis of the strain curve is applicable to digital displacement transducers.