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Hysteresis Characterization And Modeling Of Novel Thick-Film Pzt Microactuators

V. Chalvet, M. Rakotondrabe and C. Clévy

University of Franche-Comté at Besançon, FEMTO-ST Institute / CNRS UMR6174 – UFC – ENSMM – UTBM, Besançon France

Micromanipulation and microassembly tasks are increasingly required in different applications. For instance, they are often used to produce complex microsystems, or to characterize micro-objects (biological ones or artificial ones). In order to increase the success of the micromanipulation and microassembly tasks, miniaturized robotics structures (microrobots) have been being used since more than a decade. They permit to work in confined environments, consume less power, and can provide the required positioning resolution, generally in the order of tens of nanometers. Among the well known microactuators employed in these microrobotic structures are piezoelectric microactuators. They offer large bandwidth, high resolution and an ease of powering (electrical). Furthermore, they can be exploited as sensors also.

We have developed a new kind of piezoelectric microactuators recently (Fig.1.a). Based on the thinning of PZT (lead, zirconate, titanate) ceramics bonded on silicon, and called thick-film microactuators, the proposed devices possess dimensions in a scale lower than the existing ones, making them well adapted to more miniaturized structures. Furthermore, their small thickness (down to few tens of micrometers) make them require low driving voltages for larger output displacements. Finally, the developed microactuators exhibit a bandwidth larger than the existing ones. Such microactuators are very promising for the development of MEMS structures with actuation and sensing purpose.

This paper reports the characterization of the new kind of piezoelectric microactuators which shown highly nonlinear behavior, such as hysteresis and creep. In this paper we will focus on the characterization and modeling of the hysteresis of such actuators. It is shown that the gain of these thick-film microactuators exceeds 4µm/V and the related hysteresis is of 16% (Fig.1.b). A generalized Bouc-Wen model is afterwards employed to track the hysteresis. Thanks to this model, an open-loop compensation of the hysteretic behavior of the cantilever was efficiently performed.

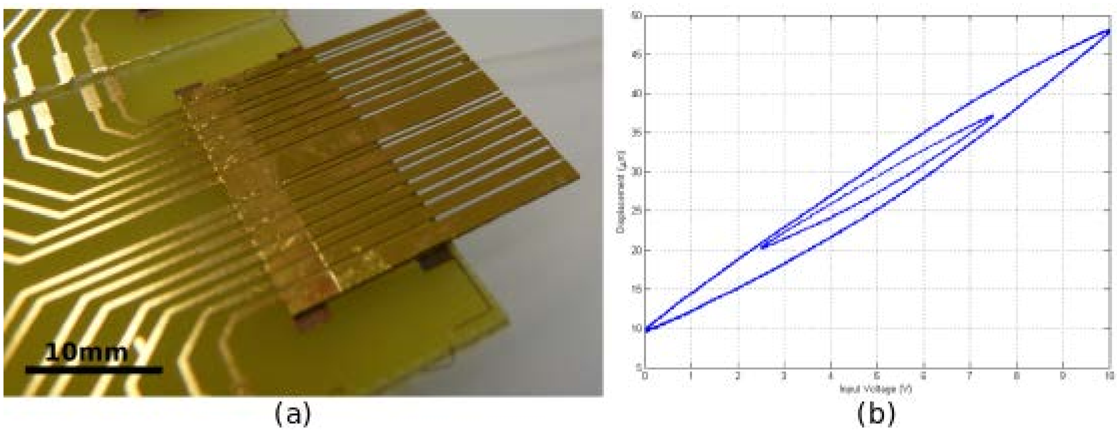

Fig. 1: (a): the new thick-film piezoelectric microactuators. (b): input-output map characteristics of the microactuator.