C-Blocks Actuators

Commonly used piezoelectric actuators produce either high forces coupled with small deflections (stacks) or large deflections coupled with low forces (films). To fill the gap between these two types of actuators, a curved piezoelectric bender actuator has been recently proposed: the *C-block* (Moskalik and Brei, 1997). It consists in a

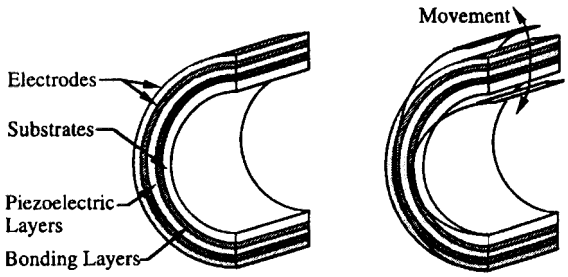

Figure 1: C-block actuator

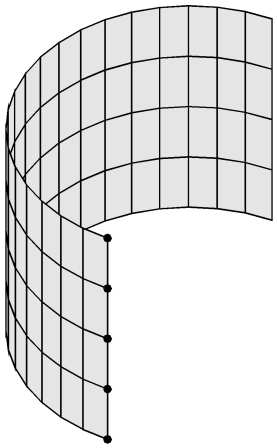

Figure 2: *FE* mesh

semi-circular ring shell clamped at the bottom edge (Fig.1). Three configurations are considered: one piezoelectric layer (*PVDF* film, $d_{31} = 2.3\ 10^{11}\ m/V$) bonded to a substrate layer, two piezoelectric layers and four piezoelectric layers bonded together. The curved shells are 22 mm wide and have a radius to the neutral axis R_n respectively equal to 14.3 mm, 13.6 mm and 14.9 mm. The properties of the materials are summarized in Table 1.

Layers	Width (mm)	Thickness (μm)	Young Modulus (MPa)
PVDF	22	52	2900
Electrode	17.5	6.5	700
Substrate	20	25	6500
Bonding	22	25	1900

Table 1: Characteristics of the materials

In this study, they are modelised using a 4×20 mesh (Fig.2) of quadrangular multilayer piezoelectric elements. The *FE* comparison between prediction results and the analytical and experimental ones from (Moskalik and Brei, 1997) for the three configurations is shown on Fig.3.

The load consists of a static voltage applied accross the electrodes of each piezoelectric layer ($-400\ V$ to $+400\ V$). The tip deflection of the actuator with respect to the applied voltage is considered.

The theoretical model used in (Moskalik and Brei, 1997) is based on a *Bernouilli-Euler* beam formulation and the *Hamilton*'s principle and neglects the normal load term (small compared to the bending moment term).

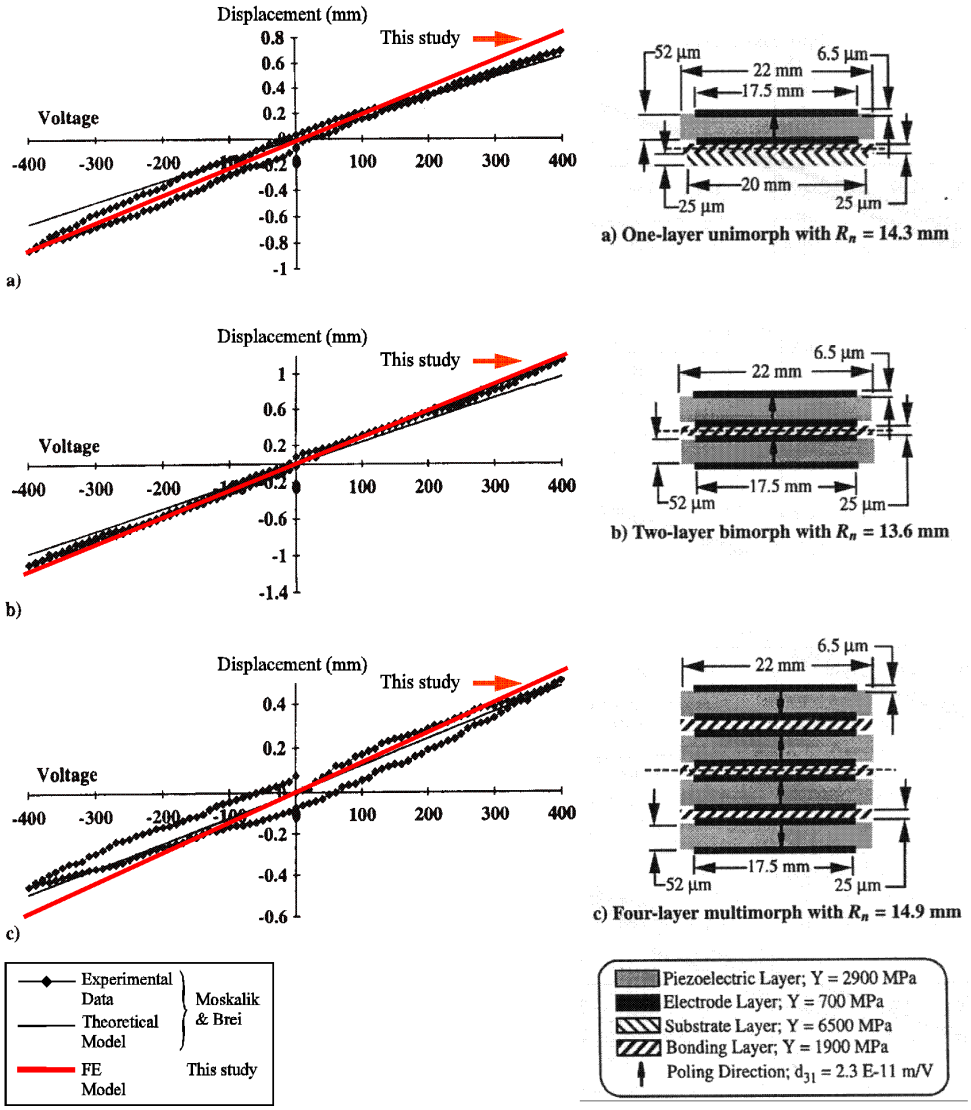

Figure 3: *C-block*
a. One layer
b. Two layers
b. Four layers

References

Moskalik, A. J. and D. Brei, 1997, "Deflection-Voltage Model and Experimental Results for Polymeric Piezoelectric C-Block Actuators", *AIAA Journal*, 35(9):1556–1558.