

High curvature sensors based on flexoelectric effect in soft semi-conducting polymer films

Julien Le Scornec^{1*} and Benoit Guiffard¹

¹ Nantes Université, CNRS, IETR UMR 6164, F-44000 Nantes, France

E-mail: * julien.le-scornec@univ-nantes.fr

ABSTRACT

A sensor based on the flexoelectric effect capable of measuring large curvature variations is proposed. The flexoelectric effect is defined as the coupling between the strain gradient and polarization in solid dielectrics and semiconductors. It can be considered as an alternative transduction mechanism to the piezoelectric effect to directly measure curvature without the need to apply a large electric field to induce a macroscopic piezoelectric-like effect.

In this study, the process for obtaining a bending sensor from a semiconducting solution of commercial (3,4-ethylenedioxythiophene):poly(styrene sulfonate) (PEDOT:PSS) deposited as a free standing thin film in the thickness range : 18 μm - 50 μm is presented. Owing to its specific properties, PEDOT:PSS films are mechanically fragile and sensitive to water. An encapsulation step in a polyethylene terephthalate (PET) polymer increases the robustness of the device while maintaining its flexibility.

The flexoelectric characterization showed a coefficient much higher than those reported in the literature for PEDOT:PSS polymers with a coefficient that reaches 76 $\mu\text{C}/\text{m}$ at 0.5 Hz (3 orders of magnitude higher than insulating polymers). In the case of PEDOT:PSS which is a mixed ionic/electronic semiconductor, flexoelectric response might be mainly attributed to short range PEDOT⁺-PSS⁻ dipole motion rather than pure ionic polarization mechanism (flexoionic effect).

It was also demonstrated that with the acquisition of the output current signal at the sensor terminals it is possible to determine the curvature of the sensor used in cantilevered beam bending configuration. The demonstration of their efficiency in converting a strain gradient into electrical energy, combined with their robustness and flexibility, makes these devices very attractive for wide range curvature sensing.