Characterisation of thin layers (Parylene) at high frequency using PZT thick film resonators for medical imaging transducer applications

Franck Levassort
LUSSI/GIP ultrasons - France

Abstract

To improve the electro-acoustic performance of a transducer, the use of matching layer(s) for medical imaging applications is (are) absolutely necessary. This layer is placed between the piezoelectric element (whose acoustical impedance is around Z=33 MRa for PZT) and the propagation medium (water Z=1.5 MRa). For high frequency ultrasonic transducer applications (in this study around 30 MHz) the thickness of the matching layer, which is near a quarter wave-length, is only of few tens of microns and the corresponding acoustical properties (longitudinal wave velocity and attenuation) are thus difficult to measure with a good accuracy. In this paper, the characterisation of the properties of several deposited thin layers of Parylene (between 10 and 30 microns) is presented. This material is a good candidate for matching layers in terms moisture resistance, acoustical properties, deposition technology and precise control of the deposited thickness. The measurements are performed using a high frequency piezoelectric thick film resonator (65 microns) fabricated by tape-casting (Ferroperm Piezoceramics Pz29). The resonator is first described and its electromechanical constants are found to be similar to those of bulk samples with the same composition. The method is based on the measurement of the electrical impedance of a multilayer structure (epoxy resin substrate, piezoelectric disk and Parylene layer) where the only unknown properties are those of the Parylene layer. By a fitting process with a KLM model (unidimensional equivalent electrical circuit) of the electrical impedance of the whole structure, the Parylene properties are deduced and presented. Moreover, this method allows to obtain directly the Parylene properties in a realistic configuration for transducer applications. Finally, high frequency transducer simulations and corresponding performance of devices integrating either tape-casted or screen-printed PZT thick films and Parylene matching layer are presented. The overall performance is compatible with medical imaging requirements.