Fabrication and finite element modeling of monolithic piezoelectric ceramic transducers with thin-walled hollow shells

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Abstract

Dimension, shape and materials choice are the most basic characteristics of a piezoelectric ceramic transducer determining the device performance. Ceramic hollow shells with thin walls with various shapes may enhance the device performance through inherent amplification mechanism and multimode vibrations. In this study, piezoelectric ceramics were fabricated in the form of thin-walled hollow bodies in various shapes by slip casting technique Slurries are prepared from lead zirconate titanate (PZT-5A) powder. Sulfynol 104E was used as antifoaming agent, Glycerol was used as plasticizer and Davran 821A was used as dispersant. The optimum dispersant content was determined through viscosity, pH measurements and sedimentation experiments. The best dispersion was obtained with 0.25 wt% Darvan821A addition for slips with 35 vol% and 45 vol% solid loading, and with 0.5 wt% Darvan821A addition for slips with 40 vol% solid loading. Gypsum molds were used to produce parts in the form of thin shells with various shapes such as hollow spheres, tubes, cones, cylinders and ellipsoids. After drying, parts were sintered at 1285oC for 90 minutes and electroded with fire-on silver paste. Fabricated parts were characterized by dielectric measurements for transducer applications and resonance frequencies of characteristic vibration modes were determined. ATILA finite element analysis software was used to analyze vibration modes (static) and associated resonance frequencies (harmonic) of these transducers.