# Distribution of Ceramic Powder Dispersed in 0-3 Piezoelectric Ceramic–Polymer Composites and Their Properties

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## ABSTRACT

The goal of this work was to study the relationship of physical properties such as acoustic impedance and density with distribution and volumetric fraction of ceramic powder in the 0-3 composites. The composites were fabricated using two methods, namely, calendering and centrifuge, with polyethylene and polyester resin as the matrix respectively and Lead Zirconate Titanate (PZT) as the filler. The morphology and distribution of the PZT particles were studied with scanning electron microscopy. The composite fabricated in a centrifuge was found to distribute more homogeneous and yielded higher physical values. The impedance and density…etc., were measured and found to increase with increasing of the volumetric fraction of the filler.

**Key words:** Piezoceramic-polymer 0-3 composite, distribution, physical properties.

## INTRODUCTION

An important consideration for transducer performance is the physical properties, such as acoustic impedance, Bulk modulus, density…etc., between the transducer and its environment (Han et al., 1991). For example, if a ceramic transducer is employed in medical use, the coupling of the energy at the transducer-load interface is very poor (Gururaja et al., 1985) because of the mismatch of their physical properties. Therefore, attempt to reduce the such properties of the ceramic transducer is one of the goals in many works. Composites consist of piezoceramic and polymer seem to meet this desire, since they have advantages over single phase ceramics. This is due to their physical properties such as Bulk modulus, density,…etc., which are low compared to those of ceramics. This allows the composites to possess low physical values, such as, acoustic impedance, etc., but considerably high flexibility, which are able to suit for coupling with low impedance load and non-flat surface such as human tissue. Regarding to the connectivity of the piezoceramic and polymer phase, there are many types of mixing (Safari, 1994). Among these types the 0-3 connectivity is considerably easy to fabricate and this is the type that we employed for this work. However, distribution of the ceramic phase proved to have so much effect on its properties therefore, study of the distribution of the ceramic phase prepared by calendering (Fries and Moulson, 1994) and centrifuge (Nhuapeng and Tunkasiri, 2002) methods were carried out. Other physical properties such as density, acoustic impedance…etc., were also measured for comparison.

There are many methods of preparing these (0-3) composites, for examples, calendering and tape casting (Fries and Moulson, 1994), painting (Hanner et al., 1989), colloidal (Han et al., 1991) and centrifuge (Nhuapeng and Tunkasiri**,** 2002). The volumetric percentages of piezoceramic loading are 50, 60, 70, 70 and 65 respectively.