Piezoelectric Ceramic Fibers and Fiber-based Piezocomposites

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Piezoelectric ceramics are materials which generate electrical charges when subjected to a mechanical stress, and conversely, they generate a mechanical strain when subjected to an electric field. Piezoelectric materials in bulk ceramic form have found widespread applications as actuators, non-destructive testing transducers, biomedical imaging probes and underwater SONARs since 1950s. However, especially in underwater acoustic applications, bulk ceramics have limitation due to their high acoustic impedance, stiffness and low sensitivities. Thus, piezocomposites consisting of an active piezoceramic phase embedded in a passive polymer matrix have been investigated since 1980s to overcome these limitations. Among piezocomposites with various connectivities, the 1-3 piezocomposites, where the active piezoceramic phase assumes a fiber form, have been the most popular and most widely investigated piezocomposite.

In this study, our research on fabrication of piezoelectric ceramic fibers using a novel technique called alginate gelation, that was developed by our research group 15 years ago, was summarized. The processing-microstructure-property relationship was discussed in detail. Examples of device applications were also presented, including 1-3 piezocomposites based on lead-based or lead-free piezoceramic compositions, single hollow fibers and crystallographically textured piezoceramic fibers.

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