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The Effect of Organic Acids on the Preparation of PZT Fibers

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Lead titanate zirconate (PZT) ceramics, films and fibers are among the most selected piezoelectric materials for transducers applications. A fine scale fiber piezo-composite with the 1-3 connectivity was recently developed [1] and is becoming an important device candidate for high frequency transducers (to operate at 30 to 150MHz) for medical imaging and other related ultrasound diagnostic equipment. PZT ceramic fibers have been prepared by sol-gel, however the brittleness of the fibers prepared by this technique limits their use. Author's previous work showed that length and strength of sol gel PZT fibers can be controlled by the acidification of the sol [2]. In this study organic acids, acrylic and methacrylic, are used to acidify PZT precursors. Macroscopic properties, molecular structure, crystallization behaviour and microstructure of the fibers are investigated as a function of content and type of acid. The molecular structure of the precursor sols and solid phases is investigated by FTIR and 13C Solid NMR. The thermal behavior of gel powders is analyzed by DTA and TGA. The crystalline phase evolution of the PZT fibers and powders is followed by XRD. The microstructure of PZT fibers is observed by SEM. It is observed that large polymeric chains are formed in the precursors acidify either with acrylic or methacrylic acid and longer gel and ceramic PZT fibers are pulled. The pure perovskite phase is obtained after heat treatment at a considerably lower temperature, 550oC. Due to the linear shape of the polymeric chains formed in the sol acidified with acrylic acid, long, round and crack free PZT fibers are prepared from this precursor. While long, rectangular and cracked PZT fibers are prepared from the methacrylic acid precursor, in which a branched furcate type structure is identified.

[1] R. J. Meyer Jr., Ph. D. Thesis, The Pennsylvania State University, 1999.

[2] Mei Zhang, I. M. Miranda Salvado, P. M. Vilarinho, J. Am. Ceram. Soc., 86(5), 775-81, 2002.