Characterization of the Pyroelectric and Piezoelectric Effect Exhibited by Alpha-Crystalline Silicon Dioxide: Potential Application as a Micro-Thermovoltaic Transducer

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The objective of this experimentation was to analyze the piezoelectric and pyroelectric effects that are exhibited by alpha-crystalline silicon dioxide. This was accomplished by using a hydraulic press and a hot plate to provide mechanical displacement and temperature increase respectively to samples of macrocrystalline quartz. Crystals were prepared through application of a conductive wire adhesive to 16 AWG stranded copper wire on the surfaces of opposite m-faces of SiO_2. A digital storage oscilloscope documented voltage production in response to temporary polarization induced by displacement and temperature. Each sample's piezoelectricity was examined by supplying a constant 100 N and a sporadic 20 N; the pyrolectricty was examined by supplying an total increase in temperature of 14° Celsius. The piezoelectric effect was observed in all samples*: voltage generation ranged from 700 to 1100 mV. *Due to incomplete contact between the opposite m-faces of one crystal sample with the hydraulic press and the base plate, the establishment of an induced polarization was not possible. This was a result of the penetration twinning exhibited by the sample, and no efforts could be made to alter crystal shape to facilitate more effective experimentation. The pyroelectric effect was observed in all samples: voltage generation ranged from 200-300 mV. All data was present in the form of minor rapid voltage increases or "spikes" that were detected by the oscilloscope. Alpha-crystalline silicon dioxide's piezoelectric and pyroelectric effects were verified and characterized. This is a confirmation of the material's potential application as a micro-thermovoltaic transducer.