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Low Temperature Degradation Behavior of ^{18}O-Containing Yttria Stabilized Zirconia

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It was experimentally identified, for the first time, that oxygen phonons or lattice vibrations of oxygen ions play an important role in the low temperature degradation, i.e. tetragonal → monoclinic martensitic phase transformation of yttria stabilized zirconia (Y-TZP). The ^{18}O-containing Y-TZP transform into monoclinc phase markedly slower than the ^{16}O-containing Y-TZP counterpart, when they were immersed in boiling water. Based on a quantum mechanical treatment of atomic vibrations, the experimental results were semi-quantitatively interpreted. The retardation of low temperature degradation by ^{16}O-^{18}O substitution is attributed to the heavier mass of ^{18}O which leads to the smaller probability to find oxygen atoms beyond certain critical displacements. The lattice vibrations or phonons of oxygen ions play an important role in the low temperature degradation of yttria stabilized zirconia.