Mechanism of ZrTiO$_4$ Synthesis by Mechanochemical Processing of TiO$_2$ and ZrO$_2$

Andreja Gajović$^1$*, Krešimir Furić$^1$, Svetozar Musić$^1$, Igor Djerdi$^2$, Antun Tonejc$^2$, Anđelka M. Tonejc$^2$, Dangsheng Su$^3$ and Robert Schlögl$^3$

$^1$ Ruđer Bošković Institute, POB 180, HR-10002 Zagreb, Croatia
$^2$ Faculty of Science, Department of Physics, POB 331, HR-10002, Zagreb, Croatia
$^3$ Fritz-Haber-Institut der Max-Planck-Gesellschaft, Faradayweg 4-6, D-14195 Berlin, Germany

* corresponding author

Abstract

High-energy ball milling initiates a solid-state reaction in an equimolar mixture of TiO$_2$ and ZrO$_2$. The first stage of ball milling induced the transformation of anatase TiO$_2$ to high-pressure phase TiO$_2$ (II), isostructural with ZrTiO$_4$. The formation of solid solutions monoclinic ZrO$_2$/TiO$_2$ and TiO$_2$ (II)/ZrO$_2$ was observed in the intermediate stage. Afterward, a nanosized ZrTiO$_4$ phase was formed in the milled product from the TiO$_2$ (II)/ZrO$_2$ solid solution. The sintering of the milled product at a temperature <1100°C was examined in situ by Raman spectroscopy. The full solid-state reaction toward ZrTiO$_4$ ceramic is completed at a temperature considerably lower than reported in the literature.

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