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Grain growth and phase transformations induced by shock waves on alpha-GeO_2 powder

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An impact experiment on a mixture of water and microcrystalline alpha-GeO_2 powder was performed with a single-stage gas gun. The recovered sample contained micrometer-scale crystals of different sizes and morphologies that correspond to 88% of alpha-GeO_2, 6.0% of monoclinic phase ($P2_1/c$, space group No. 14), 4.9% of orthorhombic phase (*Pnnm*, space group No. 58) and 1.1% of rutile-type phase.

Keywords: phase transformation; shock waves; germanium dioxide

1. Introduction

Shock and static loading techniques can induce phase transitions in solids. In the former case, the compressed state is characterized by the high rate of loading, rise in temperature and a high production of defects. These features influence the kinetics and the mechanisms of phase transitions on shocked materials [1].

Recently, ultrafast growth of high pressure phases in shock-produced melts has been reported by Tschauner et al. [2] from impact experiments with a propellant single-stage gun on fused quartz and magnesium oxide mixtures. It has been demonstrated that some high pressure silicate polymorphs can be synthesized on a time scale less than microseconds in shock experiments. Moreover, they [2] reported the formation of micro-sized crystals of wadsleyite (β-Mg_2SiO_4) from shock-induced melts, through a non-diffusive, shock-specific and ultrafast growth mechanism.

In this short note, we report preliminary results related to phase transformations and grain growth induced by shock waves on a mixture of water with microcrystalline alpha-GeO_2 powders (Figure 1). Germanium dioxide was used to carry out high pressure experiments since it exhibits a large variety of amorphous and liquid phases under pressure [3]. For example, based on static pressure experiments in diamond anvils, the following pressure-induced phase transformation sequence has been reported. An equivalent sequence has been reported for other group IV dioxides [3–7]:

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