

OXIDATION BEHAVIOUR OF MoSi₂ POWDER AT 800–1100 °C

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Oxidation process of molybdenum disilicide MoSi₂ powders is very complex and strongly depends on synthesis technology. Stable results are obtained only at high temperatures (above 1300 °C) or long holdings (tens of hours), after the solid and homogeneous layer of SiO₂ is formed on the surface. But great phase and volume changes occur at initial stages of oxidation, complicated by volatility of forming MoO₃. Experimental information for this range shows significant scatter and needs clarification.

In this study, commercial MoSi₂ powder was annealed in a furnace in an air atmosphere for up to 6 hours at 800 and 900 °C and up to 4 hours at 1000 and 1100 °C.

SEM investigation of powder annealed for 2 hours at 1000 °C revealed a heterogeneous diffusional zone on the surface that had chemical composition significantly different from initial disilicide (Fig. 1; dark areas indicate decreased molybdenum content, about 3 wt. % according to electron probe microanalysis). X-ray diffraction of oxidized powder showed the presence of β-SiO₂ (cristobalite), MoSi₂, Mo₅Si₃ and MoO₃ with weak peaks of MoO₂ and SiO₂ in quartz and tridymite modifications.

The change of the mass of the powder at all temperatures passed through a maximum (see Figure 2). The reason of initial increase of mass was the reaction $\text{MoSi}_2 + (7/5) \text{O}_2 \rightarrow (1/5) \text{Mo}_5\text{Si}_3 + (7/5) \text{SiO}_2$, and that of subsequent decrease was $(1/5) \text{Mo}_5\text{Si}_3 + (21/10) \text{O}_2 \rightarrow (3/2) \text{SiO}_2 + \text{MoO}_3$, since MoO₃ is volatile and evaporates. At 900, 1000 and 1100 °C fast decrease of mass slowed down after formation of continuous layer of SiO₂ on the surface that prevented MoO₃ from leaving the particles.

Kinetics of the first two stages of oxidation (before formation of SiO₂ layer) can be described by a power law $\Delta m(t)/m_0 = (A_1 t)^1 - (A_2 t)^{3/2}$ where $A_1 = 0.043 \exp(-6540/T)$ and $A_2 = 0.14 \exp(-8140/T) \text{ s}^{-1}$.

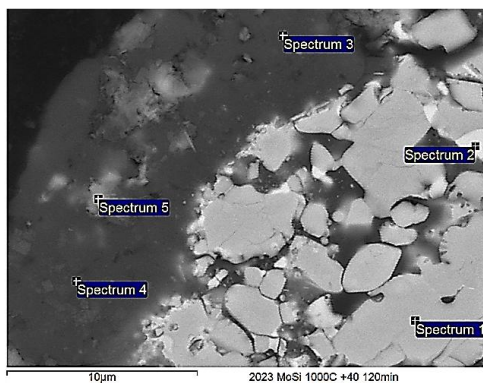


Figure 1. SEM microstructure of MoSi₂ powder oxidized for 2 hours at 1000 °C

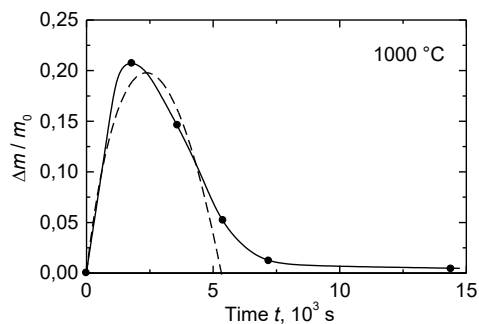


Figure 2. Relative change of mass of the powder at 1000 °C