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Mechanism of 2/1- to 3/2-mullite transformation at 1650 °C

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ABSTRACT

The transformation of 2/1-mullite single crystals into stable 3/2-mullite was investigated using reaction couples of 2/1-mullite cut parallel to (001) and silica glass at 1650 °C. A thin layer of 3/2-mullite formed at the surface of the parent 2/1-mullite crystal. Between 3/2- and 2/1-mullite a gradual transition layer of about 1 μm exists. This gradual transition zone and the lack of any interface between the substrate 2/1-mullite and the newly formed 3/2-mullite implies a topotactic transformation mechanism controlled by Al, Si, and O interdiffusion with preservation of the basic crystal structure, especially the AlO_6 octahedral chains. The number of O atom vacancies is reduced going from 2/1- to 3/2-mullite, as shown by a gradual decrease of the corresponding superlattice intensities in electron diffraction patterns. As the transformation requires diffusion of Al out of and of Si and O atoms into the 2/1-mullite crystal, a coexisting silicate melt is required as an Al sink and as a source of Si and O atoms.