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Surface energy of fayalite and its effect on Fe-Si-O oxygen buffers and the olivine-spinel transition

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Abstract

The surface energy (hydrated surfaces) of fayalite (α-Fe_2SiO_4) was determined to be 2.47 ± 0.25 J/m^2 using high-temperature oxide melt solution calorimetry. This is larger than the surface energy of magnetite (Fe_3O_4), but lower than that of forsterite (α-Mg_2SiO_4). The changes in the positions of the quartz-fayalite-magnetite (QFM) and quartz-iron-fayalite (QIF) buffers with particle size reduction were calculated. QFM is lowered in f_{O_2} by 3–7 log units as a function of temperature for 30 nm particles while QIF is raised by 1–2 log units. The estimated surface energy difference between olivine and spinel polymorphs decreases the pressure of the olivine-spinel transition in Fe_2SiO_4 by about 1 GPa.

Keywords: Olivine-spinel transition, nano fayalite, quartz-fayalite-magnetite (QFM) buffers, quartz-iron-fayalite (QIF) buffers, surface energy