



Thermodynamic model for diffusion controlled reaction rim growth in spherical geometry: Application to the forsterite-enstatite-quartz system

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We present a thermodynamic model for diffusion controlled growth of a reaction rim of phase γ between the mutually incompatible phases α and β in a two component system. We investigate the case, where α has spherical shape and is embedded in a matrix of β . It is shown that in spherical geometry the rim growth rate depends on the matrix-inclusion arrangement and will, in general, be different, if the α and β phases are interchanged between matrix and inclusion. The model is applied to growth of enstatite rims at quartz-forsterite interfaces in the MgO – SiO₂ model system. Two different geometrical setups are considered, namely a spherical grain of forsterite in a quartz matrix and a spherical quartz grain in an forsterite matrix. It is shown that, for a given set of pressure-temperature conditions and for a given set of mobilities of the MgO and SiO₂ components the rim growth rate is different for the two matrix inclusion arrangements. Our model predicts an enhanced rim growth rate for the setup, where quartz is enclosed in a forsterite matrix. For enstatite rims that were grown at forsterite-quartz contacts at experimental conditions of 1000°C and 1 GPa we find that diffusion of the MgO component was rate limiting for reaction rim growth. The bulk effect of the diffusion of MgO bearing species across the poly-crystalline enstatite rim at these conditions is described by an MgO self diffusion coefficient in the range of $D_{MgO} = 3 \cdot 10^{-18}$ to $2 \cdot 10^{-19}$ m²/s.