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Experimental exsolution of alkali feldspar

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Alkali feldspars of intermediate composition have been exsolved experimentally during annealing at 500 and 550^{o}C and 1 bar. The starting materials were gem quality sanidine from the Eifel with an original composition of X_{Or} = 0.85 and gem quality orthoclase from Madagaskar with an original composition of X_{Or} = 0.95. These feldspars were exchanged with an NaCl-KCl melt with a molar NaCl/KCl proportion of 80/20 at 850^{o}C and 1 bar to produce chemically homogeneous alkali feldspar with a composition of X_{Or} = 0.4. This composition corresponds to the temperature maximum in the alkali feldspar solvus, which is at about 650^{o}C at 1 bar. The intermediate feldspars were then annealed in the unstable region at 500 and 550^{o}C and 1 bar to provoke unmixing. Run durations were 8, 16, 32, and 64 days. In all runs the feldspars developed a lamellar microstructure, which is visible on TEM bright field images in cuts taken normal to the [010] direction. This microstructure is interpreted to result from spinodal decomposition as is expected to occur during anneling in the unstable region. The characteristic wavelength of the lamellae increases with time, where the wavelength seems to be proportional to the cube root of time. From linear extrapolation the initial wavelength is estimated at 15 nm for annealing at 550^{o}C and at about 8 nm for annealing at 500^{o}C, where the initial wavelength is similar for both materials prepared from sanidine and orthoclase. The rate of coarsening is significantly higher for the 550^{o}C experiments than for the runs at 500^{o}C testifying to the temperature dependence of Na-K interdiffusion. The initial wavelength of the lamellar microstructure is related to the energy associated with phase boundaries, whereas the rate of coarsening reflects the rate of Na-K interdiffusion. Our unmixing experiments thus allow to calibrate diffuse interface models for spinodal decomposition as presented by Petrishcheva and Abart (2009). With this calibration a tool is provided to extract cooling rates from the characteristic grain size and from the compositions of the exsolved phases in perthitic alkali feldspar.

Petrishcheva E, Abart R (2009): Exsolution by spinodal decomposition: I: evolution equation for binary mineral solutions with anisotropic interface energy. Am Journ Sci 309:431–449