

Exsolution in germanium substituted alkali feldspars: A SEM-EMS study

Sayad, Sogol¹ Abart, Rainer¹ Petrishcheva, Elena¹

¹Free University Berlin

We investigate exsolution microstructures in germanium substituted alkali feldspar in the system $\text{Na}[\text{AlSi}_{0.9}\text{Ge}_{2.1}\text{O}_8] - \text{K}[\text{AlSi}_{0.9}\text{Ge}_{2.1}\text{O}_8]$. The samples were prepared by Kusatz et al (1987) and were granted by courtesy of H. Kroll. For details on feldspar synthesis see Kusatz et al (1987). Like with silicate feldspars the binary solid solution of the germanium substituted alkali feldspars is characterized by an asymmetric miscibility gap, which only closes at about 880°C at 1 bar. Ge-substituted alkali feldspars of intermediate composition were annealed at temperatures between 450 and 750°C and for several hours to 128 days to induce exsolution. We selected two compositions at $X_{\text{K-sp}} = 0.20$ and $X_{\text{K-sp}} = 0.35$ for microstructure investigation. The composition of $X_{\text{K-sp}} = 0.35$ coincides with the position of the thermal maximum of the coherent solvus. Practically all annealing temperatures fall below the coherent spinodal, and exsolution is expected to have occurred by spinodal decomposition. The composition $X_{\text{K-sp}} = 0.20$ falls onto the relatively steep limb of the solvus and annealing temperatures fall into the region of metastability between the coherent spinodal and binodal curves. Exsolution is hence expected to have occurred by a nucleation and growth mechanism for this composition. Using scanning electron microscopy and element mapping we identify sodium rich and potassium rich exsolution lamellae of 1 to 10 μm width in all annealed samples. The lamellae are evenly distributed over the host grain. They show, however, substantial increase in thickness towards cracks or grain boundaries, indicating that these two dimensional defects had an influence on exsolution and coarsening. We do image analysis to obtain mean values and distributions for lamellar width to determine the characteristic size, l_0 , of compositional fluctuations during the exsolution stage and the coarsening kinetics. Coarsening was shown to follow the simple rate law $l = l_0 + k \cdot t^{1/3}$ where l is the characteristic lamellar width, k is a kinetic constant and t is time (Yund and Davidson 1978). We find that even for exsolution within the spinodal region of the phase diagram this simple relation is obscured by the influence of pre-existing heterogeneity in the starting material, which produces a rather wide size distribution for lamellar width.

References

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