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Structural change of plagioclase glasses by mechanical milling

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Plagioclase($NaAlSi_3O_8$-$CaAl_2Si_2O_8$) melt is important component of magma of the Earth. The information for the structure change of plagioclase glasses by milling is useful to understabd earthquake and fault formation and material industry. Silicate glass changes its structure and density even milling as well as heating and compression. For example, it was reported that SiO_2 glass increase its density with Si-O-Si angle shrinkage and formation of small rings of SiO_4 tetrahedra[1]. In this study, we analyzed the structural changes with milling by X-ray diffraction and FTIR experiments and discussed the composition dependence of milling behaviors of plagioclase glasses.

We synthesized An100 and Ab50An50 composition glasses and milled up to 500 hours by ball mill technique. These milled glasses were analyzed by particle size, X-ray diffraction, and FTIR measurements. By milling about 20-80 hours, apparent average particle size decreases to about 2 micron in diameter. This data also indicate that An100 glass is easy to downsizing than the other glasses. After 20-80 hours, the size re-increased. This indicates the formation of aggregation of small milled glass particles.

The position of First Sharp Diffraction Peak (FSDP) at around 2theta=22-26 deg of XRD pattern related to the size of basic structure unit such as 4 and 6 membered rings of TO_4 (T=Al/Si) tetrahedra. This peak position shifts to high 2theta angle with increase of small ring structure of TO_4 tetrahedra. Obtained results indicate that the structure Ab100 glass change 6 membered ring of TO_4 dominant to the mixture of 4 and 6 membered ring structure. On the other hand, the shift for An100 glass is small. This may indicate that the structure of non-milled An100 glass has already 4 membered rings dominant structure[2]. Previous studies for SiO_2 glass reported the density increase by milling related with these structure changes[1]. The shift of FSDP position of Ab50An50 is larger than the others. Therefore, the structural change of Ab50An50 glass may be larger than the others. The results for FTIR also suggest these results. However, the origin of this variation is complex. A possibility may be formation of the units centered as Na^+ and Ca^{2+} ions.

References
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