A basic study on effects of internal stress on formation efficiency of radiation-induced center for ESR and luminescence dating

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Radiation effects on minerals, especially quartz and feldspar, have been studied by electron spin resonance (ESR) or luminescence and applied to geological dating. Some minerals are under very high pressure and exposed to environmental radiation. Although ESR and luminescence dating is based on formation and accumulation of radiation defects in samples, effects of internal stress on formation efficiency of the defects has not been studied well.

The borosilicate glass is well known as Pyrex and a matrix for confinement of high-level radioactive waste. Hirai and Ikeya (under contribution) reported that milling process made Boron Oxygen Hole Center (BOHC) unstable in Pyrex. The formation efficiency of the BOHC by gamma-rays may also depend on the internal strain in Pyrex. In this paper, BOHC in borosilicate glass instead of minerals was measured by ESR to investigate effects of internal stress on formation efficiency of the defects.

Each Prince Rupert's drop that had a head and a long tail was formed by dropping molten Pyrex glass into water. The outside of the sample is compressive strain and the inside is tensile. In order to reveal relations between residual strain and radiation effects, they were annealed at various temperatures.

The formation efficiency of BOHC in the Prince Rupert's drops decreased with internal stress decreasing. This means that the activation energy or the thermal stability of the BOHC was varied due to lattice distances or angles induced by the internal stress. On the presentation, ESR-CT imaging of the drops will be reported as well. This may reveal the difference between a compressive layer in the drop and a tensile one. This kind of study may be considered in ESR and luminescence dating of the samples with high internal stress.

Reference

M.Hirai, M.Ikeya: Effects of milling process on the ESR center formation in Pyrex glass by subsequent gamma-rays irradiation, Jpn. J. Appl. Phys., Submitted