Thermal Annealing of Recoil Atoms in Neutron Irradiation of Inorganic Phosphorus Compounds

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The recoil effects in neutron-irradiated phosphorus compounds have been reported by several investigators. It was found that these phenomena were very complicated. The radiochemical distribution of phosphorus recoil atoms was remarkably effected by the condition of irradiation. The fact that the distribution of recoil atoms was changed by thermal annealing was pointed out by Lindner and Harbottle[1] and also by Yoshihara and Yokoshima[2]. The effect of thermal annealing, however, was not investigated systematically in these papers. The present authors studied these effects in a series of inorganic phosphorus

1) L. Lindner and G. Harbottle, CENT 70 (presented at the Symposium on Chemical Effects of Nuclear Transformations, Prague, October 1960).
2) K. Yoshihara and T. Yokoshima, This Bulletin, in press.

compounds in crystal and obtained the following results.

The samples which were irradiated in JRR-1 reactor (neutron flux 10^{11}n./cm^2 sec., fast neutron was less than 5%) for 15 hr., were heated in an electric oven, dissolved in water, and separated by paper chromatography. The developing agent for this separation was a mixture of 2 N nitric acid and *n*-buthanol (1 : 1 ratio)[2].

On the isothermal annealing of irradiated sodium orthophosphate crystal (anhydrous, tribasic) at 167°C, the orthophosphate fraction increased remarkably, whereas the pyrophosphate fraction decreased appreciably, but the phosphite fraction* slightly decreased. This is presented in Fig. 1. The second order kinetics was applied to the rate of the decrease of the pyrophosphate or the polyphosphate fractions. On the other hand, the slight decrease of phosphite fraction followed approximately first order kinetics and the energy of activation in the phosphite annealing seemed to be higher than that of pyrophosphate or polyphosphate fractions.

In the case of phosphate crystal (anhyrous, dibasic) the orthophosphate fraction first increased and then decreased, whereas the pyrophosphate fraction first decreased and then increased. The polyphosphate fraction decreased monotonously. The slight decrease of the phosphite fraction was observed. The data on each fraction are shown in Fig. 2 as a function of annealing time. The decrease of the orthophosphate fraction corresponded to the increase of the pyrophosphate fraction, and therefore, this is interpreted as the results of the thermal polymerization.

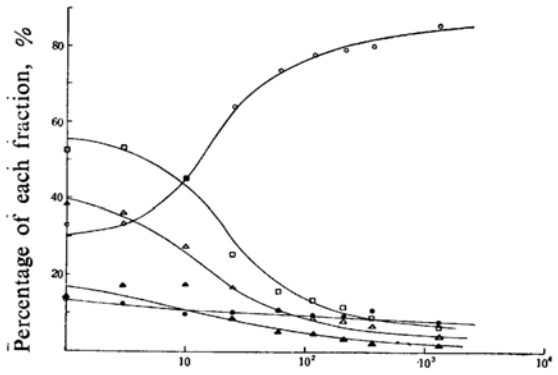

Fig. 1. Changes of distribution of recoil atoms in irradiated sodium phosphate crystals (tribasic) by thermal annealing at 167°C.
- ○ Phosphate
- ● Phosphite (+Hypophosphite)
- □ Pyrophosphate+polyphosphate
- △ Polyphosphate
- ▲ Pyrophosphate

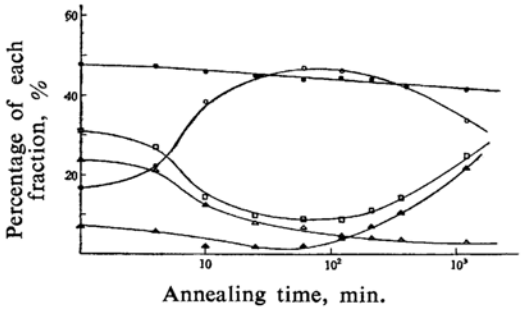

Fig. 2. Changes of distribution of recoil atoms in irradiated sodium phosphate crystals (dibasic) by thermal annealing at 166°C.
- ○ Phosphate
- ● Phosphite (+Hypophosphite)
- □ Pyrophosphate+polyphosphate
- △ Polyphosphate
- ▲ Pyrophosphate

The annealing effect of sodium pyrophosphate was also investigated. It was shown that the pyrophosphate fraction remarkably increased and the polyphosphate fraction decreased. However, both fractions of orthophosphate and phosphate only slightly decreased.

Further more delails are to be reported in full papers.

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* This fraction might include hypophosphite because hypophosphite was not separable from phosphite by the present method.