A Study on Wigner Energy Release Spectrum of Irradiated Graphite

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Stored Wigner energy spectrum of the thermal column graphite from Korean research reactor 2 (KRR-2) has been measured using the linear-rise method measurement. The kinetics of Wigner energy release have been shown to be very complicated forms so that the overall reaction rates were considered as first-order rate equations with variable activation energy contents like the following general equation.

$$\frac{dG(E,t)}{dt} = -\nu G(E,t) \exp^{-\frac{E}{kT}}$$

where $G(E,t)$ is the release Wigner energy at time t, E the variable activation energy, k Boltzmann constant, v the frequency factor, and T the temperature at time t. This means that the activation energy for Wigner energy release rate equation is not an constant value, but the variable of the temperature function. Therefore, the Wigner energy release behavior in the graphite matrix rearrangement during annealing might be considered as an consecutive irreversible reaction. A typical values of the variants in Wigner energy release equation of the irradiated graphite from KRR-2 have been shown the following results: $E = (33.7 - 1.83 \log a)T \times 10^{-4} - 0.037$, $\nu = 4.66 \times 10^{14}$, $a = 10\,℃/\mathrm{min}$ (ramp rate).

Some graphites in different locations in KRR-2 reactor core have been shown in different ways of energy release curves. The apparent decomposition of Wigner energy release spectra to three peaks or more peaks and/or great amount of tailing may be caused by annealing of interstitials and vacancies in the distorted graphite structure. In Iwata scheme the energy release curve of three peaks was supposed by successive reaction model having three activation energies. In annealing test of the irradiated graphite samples from KRR-2 the similar results could be measured. This energy release reaction mechanism in annealing process proposed in Iwata scheme might be considered a successive irreversible reactions of three stages.

As a result, various types of Wigner energy release curves were measured in the irradiated graphites of KRR-2 and the applicable activation energy models were supposed to be the function of distance from the reactor core.