Study of neutron induced damage in ADS related metals using Positron Annihilation Spectroscopy (PAS) and Monte-Carlo simulation

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Abstract:

In the present work, the effect of neutron irradiation on the samples of accelerator driven subcritical system (ADS) related metals such as aluminum, nickel, copper, niobium, molybdenum, and lead was studied using Positron Annihilation Doppler Broadening Spectroscopy (PADBS). These Samples were irradiated by a 5Ci Am(Be) neutron source. The simulated flux of emitted neutrons at irradiation position, 4 cm from source, is $3.3x10^5$n/sec/cm^2. These measurements of PADBS and electric resistivity were taken for different irradiation period from 35days to 264days. Doppler broadening of annihilation peak for all samples at different irradiation time periods was characterized by the determination of S and W parameter. The S parameter of materials increases with neutron irradiation time or neutron fluence whereas the W parameter decreases. Also, the resistivity increases by irradiation. The Simulation work was also done for the study of radiation damage by neutron irradiation using JA-IPU Monte-Carlo code.

Samples of four elements (Al, Cu, Ni and Pb) having fcc structure have linear dependence of resistivity and S & W parameter with neutron fluence whereas two elements (Mo and Nb) with bcc structure have exponential dependence and show the saturation of defect production at higher irradiation states [1, 2]. Simulation results have also been indicating the different behavior of Mo and Nb [3, 4]. These observations conclude that the defect production by neutron irradiation also depends on the lattice structure of the materials.

Reference:

1. V. Slugen, What Kind of Information we can obtain from Positron Annihilation Spectroscopy, DG JRC, Institute for Energy (2006).
2. Naresh Chejara, S.K. Gupta et. al., Study of defect production in neutron irradiated Cu, Ni and Pb using positron annihilation spectroscopy (PAS), Materials Today Proceedings (2020).
3. N. Raghaw, V. Kumar, A. Tundwal and Yu.A. Korovin, A Monte Carlo Simulation of Radiation Damage of SiC and Nb Using JA-IPU Code, Journal of Power and Energy Engineering, DOI: 10.17265/1934-8975/2015.11.005 (2015).
4. C.H.M. Broeders and A. Yu. Konobeyev, Defect production efficiency in metals under neutron irradiation, Jn. Nucl. Mat. 328, 197 (2004).