

The experimental validation of the *arc-dpa* (survived Frenkel-pairs defects) cross sections

Introduction

The arc-dpa could be experimentally validated in the irradiation experiments at liquid helium temperatures when created defects are frozen and thus are prevented from migration and annealing.

The experimental displacement cross section σ_{exp} is derived (see, e.g. [1, 2]) from the measured electrical resistivity increment $\Delta\rho$ per incident particle fluence $\Delta\Phi t$ (or damage resistivity rate $\Delta\rho/\Delta\Phi t$):

$$\sigma_{exp} = \frac{1}{\rho_{FP}} \frac{\Delta\rho}{\Delta\Phi t} \quad (1),$$

where ρ_{FP} is a specific resistivity change per Frenkel-pair for metals.

The systematic evaluations of ρ_{FP} are based on the original experimental data measured by different methods, see [1 - 3]. For the metals where ρ_{FP} was not measured yet, several evaluations [2, 3] proposed systematics which are based on the resistivity at the melting points. However the obtained uncertainties for ρ_{FP} are still too high ($\approx 50\%$) that results to large uncertainties also for σ_{exp} .

The measured damage resistivity rate $\Delta\rho/\Delta\Phi t$ could be found in the overviews [1- 3, 5], in the original historical [6-8] or recently published papers [9].

Example: Measured Data for Cu.

Parameter	Neutrons (mean or mono energies)			Protons (mono energies)	
	0.7 MeV ANL-CP5 [5]	14 MeV RTNS-I/II LANL [6]	≈ 20 MeV d(40 MeV)-Be ORNL [6]	1100 - 1940 MeV BNL [7]	125 MeV KURRI FFAG [9]
$\Delta\rho/\Delta\Phi t, 10^{-31} \Omega \text{ m}^3$	0.424	2.48	2.11	3.66	3.41
$\rho_{FP}, 10^{-6} \Omega \text{ m/dpa}$	$2.2 \pm 50\%$ [2]				
<i>arc-dpa</i> , b	193	$1127 \pm 50\%$	$960 \pm 50\%$	1390 - 1870	$1550 \pm 50\%$

The measured neutron and proton induced *arc-dpa* cross sections are compared with calculated ones (taken from [DXS](#) database [10]).

Copper

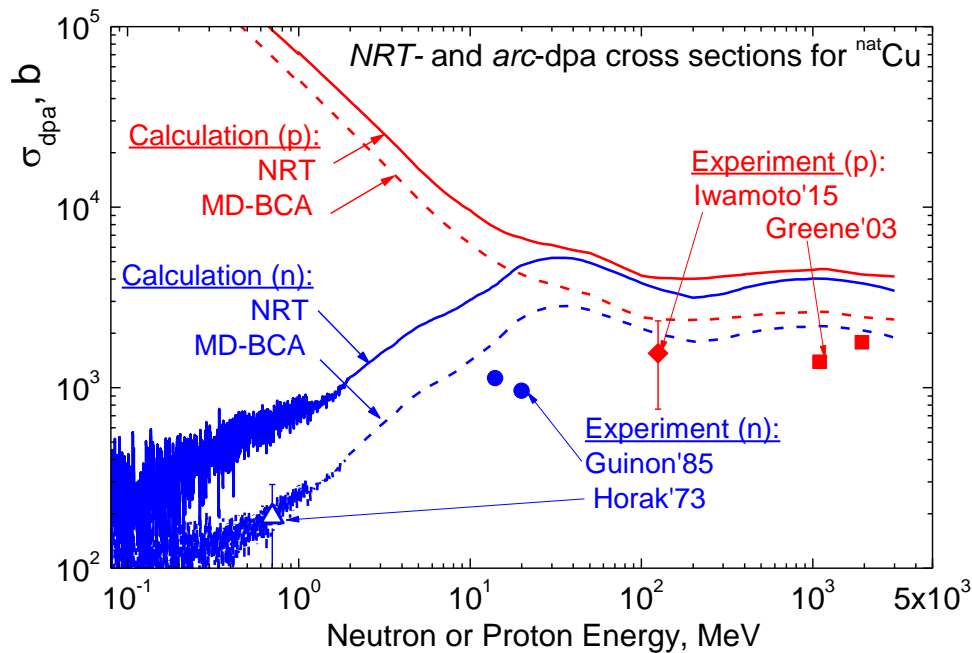


Fig. 1. Neutron and proton induced measured (only *arc-dpa*) and evaluated (DXS *NRT*- and *arc-dpa*) cross sections for Copper.

Iron

References

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