Journal of
Nuclear Engineering

Supplementary Materials

A Rate Theory Model of Radiation-Induced Swelling in an Austenitic Stainless Steel

Malcolm Griffiths [1,2,3,*], Juan Ramos-Nervii [4,5] and Larry Greenwood [6]

1 Dept. Mechanical & Materials Engineering, Queens University, Kingston, ON K7L 3N6, Canada
2 Dept of Mechanical & Aerospace Engineering, Carleton University, Ottawa, ON K1S 5B6, Canada
3 ANT International, 448 50 Tollered, Sweden
4 Departamento de Materiales, Nucleoelectrica Argentina S.A., Francisco N. Laprida 3163, B1603AAA Villa Martelli, Argentina; jnervi@na-sa.com.arl
5 Centro Tecnologico Aeroespacial / Departamento de Aeronautica, Facultad de Ingenieria, Universidad Nacional de La Plata, Avda. 1 esq. 47, La Plata B1900TAG, Argentina
6 Pacific Northwest National Laboratory, Richland, WA, 99352, USA; larry.greenwood@pnnl.gov
* Correspondence: malcolm.griffiths@queensu.ca

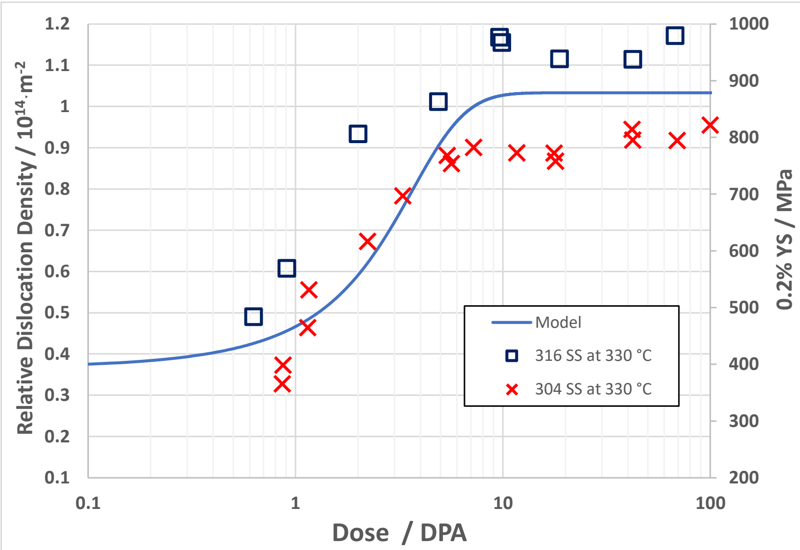

Figure S1. Uniaxial tensile yield stress data used for calculating swelling for austenitic stainless steels (316 SS and 304 SS) irradiated and tested at 330 °C. Modified from [51]. The yield stress is shown on the right hand ordinate and the relative dislocation density assuming that the change in yield stress is linearly related to the change in dislocation density, which saturates at a maximum value at a given dose, on the left hand ordinate. The model is not intended to be mechanistic in any way but can serve as a means of including an evolution term for the dislocation density represented by the yield stress.

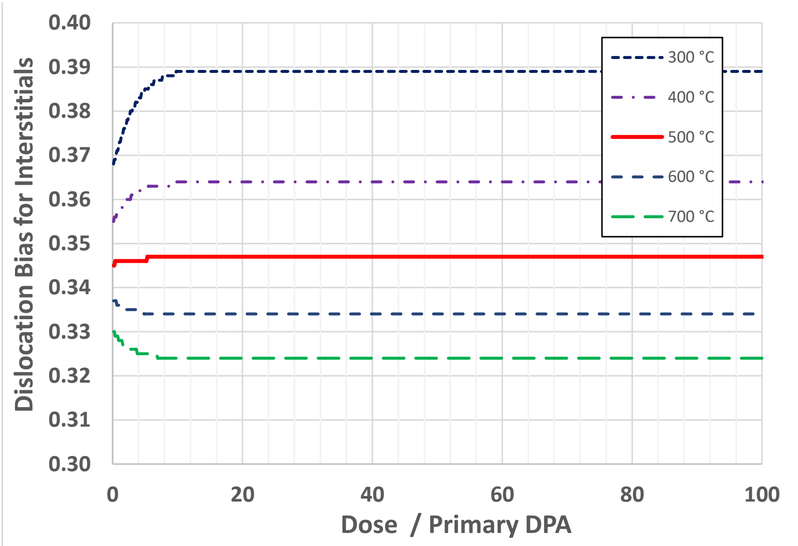

Figure S2. Calculated variation in interstitial bias for dislocations in 316 SS as a function of irradiation temperature during irradiation in EBR-2.

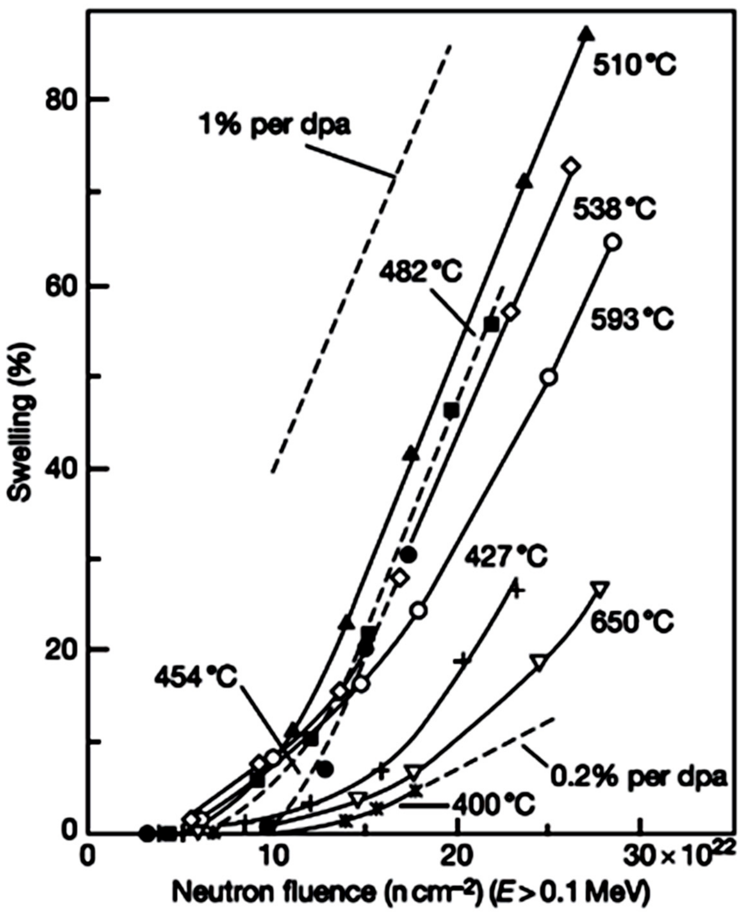

Figure S3. Swelling determined by density change as a function of irradiation temperature and dose, as observed in 20% cold-worked AISI 316 irradiated in the EBR-2 fast reactor. All measurements at a given temperature were made on the same specimen after multiple exposures with subsequent reinsertion into the reactor. This procedure minimized specimen-to-specimen data scatter and assisted in a clear visualization of the post-transient swelling rate. Reproduced (with permission) from [Garner, F.A. Radiation-Induced Damage in Austenitic Structural Steels Used in Nuclear Reactors.

In Comprehensive Nuclear Materials, 2nd ed.; Konings, R., Stoller, R. Eds.; Elsevier: Oxford, UK, 2020; Volume 3, pp. 57–168]. Copyright Elsevier, 2020.

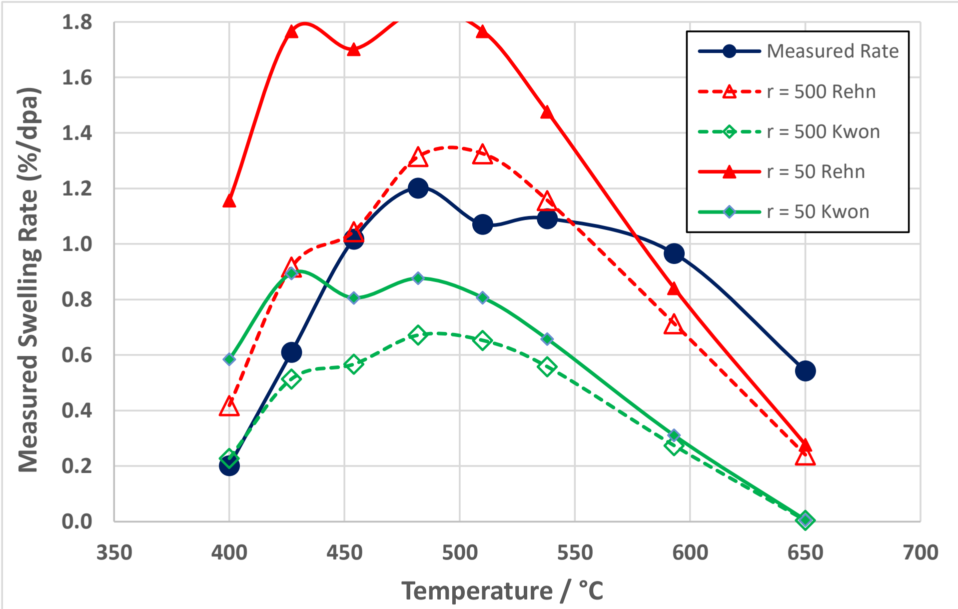

Figure S4. Measured and predicted volume swelling rates for cold-worked 316 stainless steel irradiated in EBR-2, row 2 at various temperatures and doses for a cavity number density corresponding to the upper dashed line in Figure 8, a cavity surface energy = 2 J·m^{-2} and two different models for FMD production (see text).

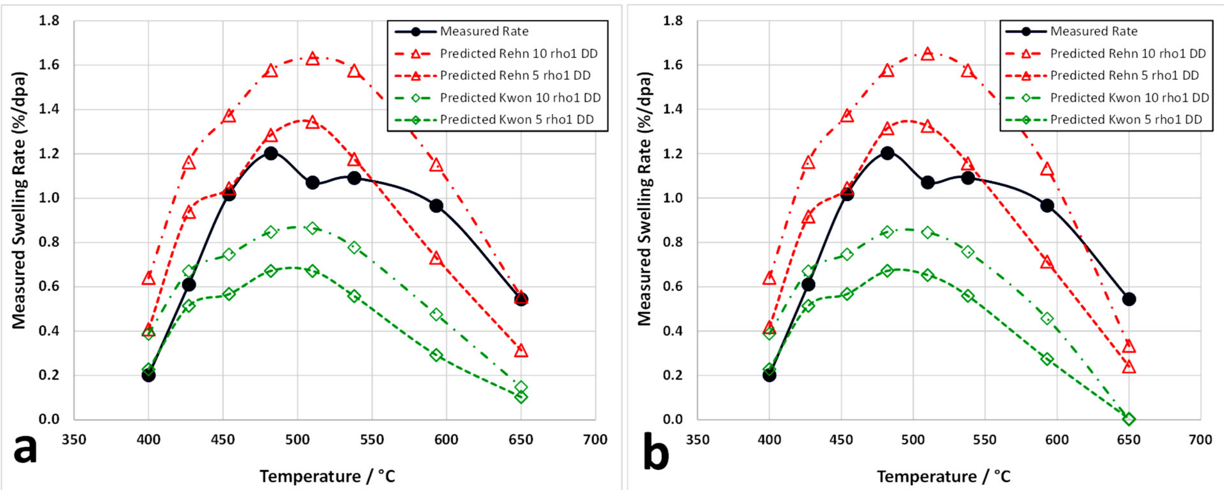

Figure S5. Measured and predicted volume swelling rates for cold-worked 316 stainless steel irradiated in EBR-2, row 2 at various temperatures and doses for two variations in cavity number density (rho1) and two different models for FMD production (see text): (**a**) cavity surface energy = 1 J·m^{-2}; (**b**) cavity surface energy = 2 J·m^{-2}.