A MODEL OF HOMOGENEOUS SEMICOHERENT INTERPHASE BOUNDARY FOR HETEROPHASE SUBSTITUTION ALLOYS UNDER IRRADIATION

Oleksandr Borysenko

National Science Center

"Kharkiv Institute of Physics and Technology"

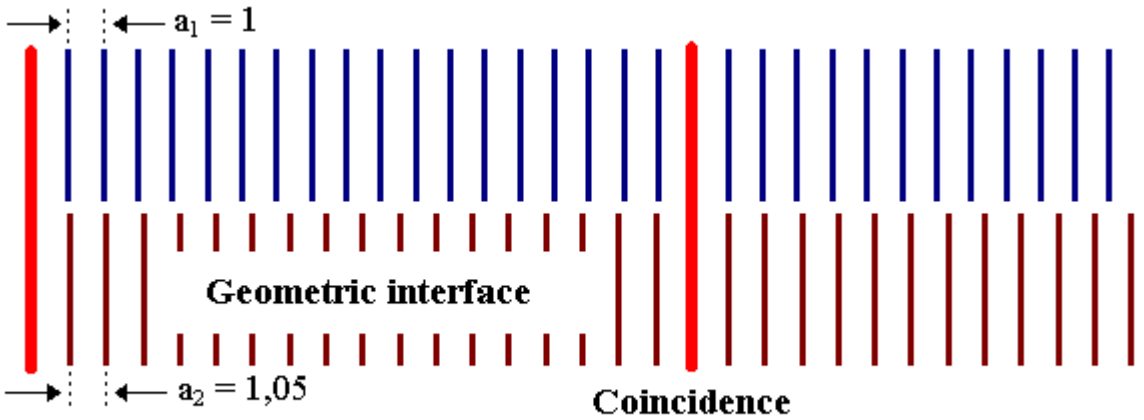
Kharkiv, Ukraine

Motivation [I. Monnet et al., J. Nucl. Mater. 335 (2004) 311]:

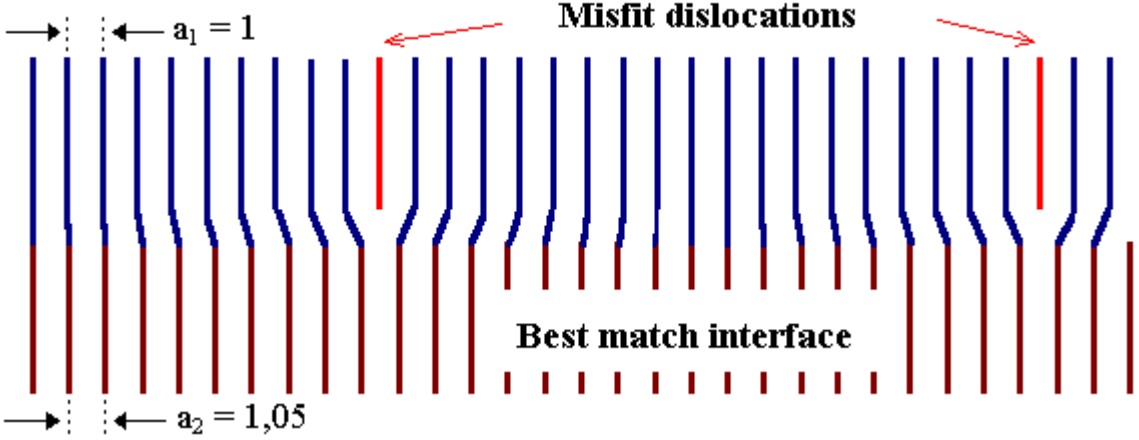
- Neutron irradiation in Phénix reactor leads to dissolution of Y_2O_3–based precipitates in the ferritic matrix at high temperatures and irradiation doses;
- Irradiation with 1 MeV He ions (region of electron losses) has no effect on the precipitates;
- Irradiation with 300 keV Ar ions (region of PD production) leads to partial dissolution of the precipitates;
- Irradiation with 1 MeV electrons leads to partial dissolution of MgO-based precipitates in EM10;
- At equal irradiation doses and temperatures the electron (cascadeless) irradiation has more effect than the ion (cascade-producing) one;
- The necessary condition of dissolution is PD production inside the precipitate;
- Recoil dissolution (ballistic mechanism) gives about 10% of the observed dissolution rate;
- Dissolution rate grows up with temperature increase.

Conclusion: dissolution is controlled by thermoactivated transfer of isolated nonequilibrium PD across the interphase boundary

A model of homogeneous semicoherent interphase boundary



- Misfit dislocations are sinks for radiation-produced nonequilibrium PDs
- Coherent regions of the boundary are transparent for PDs



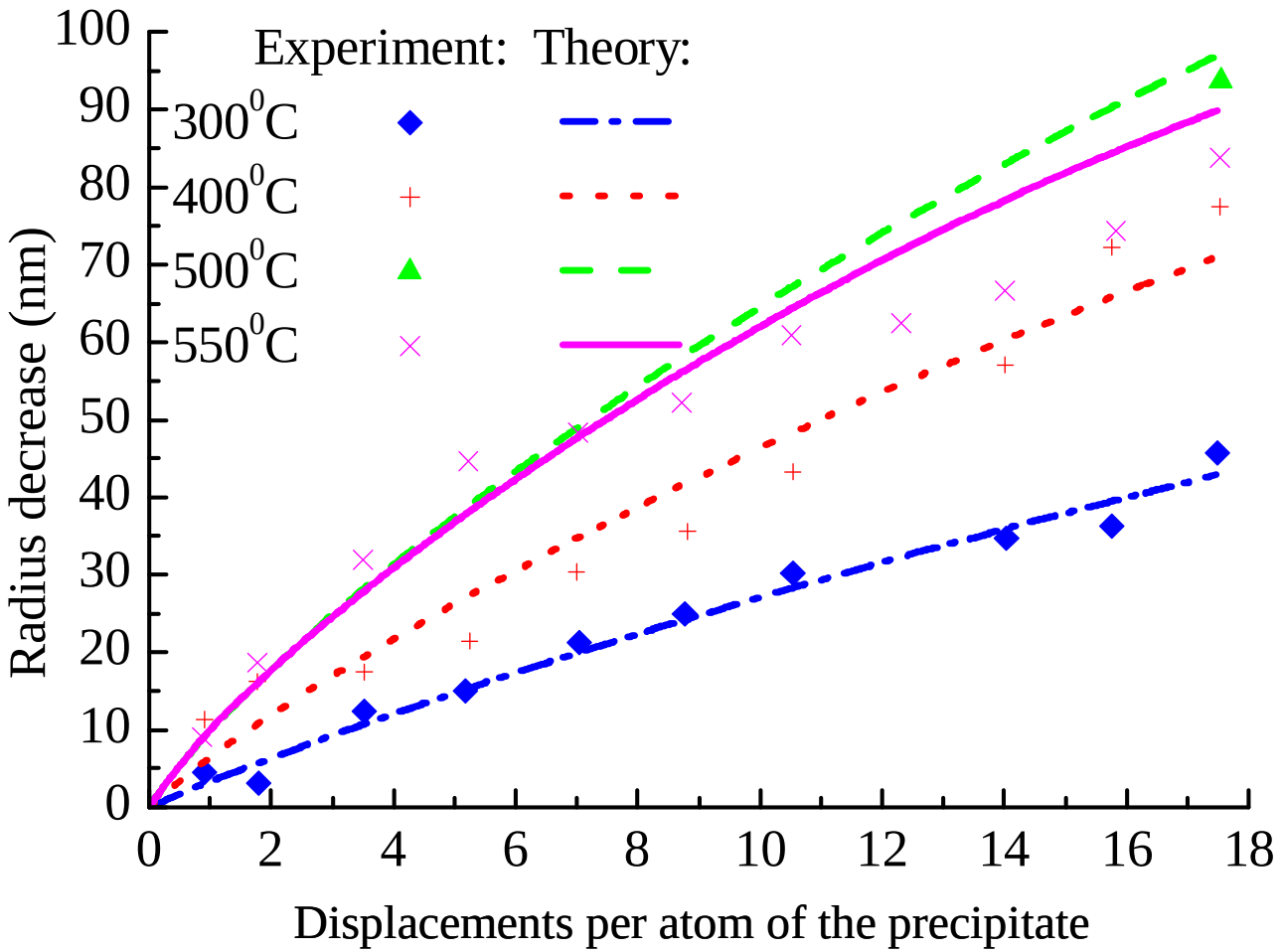
A normal component of average PD flux at the boundary:

$$j_n^{\varphi}(r_p) = j_{n\,a}^{\varphi}(r_p) + j_{nt}(r_p)$$

Absorbed component: $j_{n\,a}^{\varphi}(r_p)$

Transferred (thermoactivated) component: $j_{nt}(r_p)$

Comparison of the model results to some experimental data



Decrease of the radius of MgO-based precipitates under 1 MeV electron irradiation
[I. Monnet et al. JNM (2004) **335**, 311]

Conclusions

- ✓ The model of homogeneous semicoherent interphase boundary provides a phenomenological description for the processes of absorption and thermoactivated transfer of irradiation-produced nonequilibrium point defects at a semicoherent boundary between a heterophase precipitate and a substitution solid solution.
- ✓ The main result of the model is an expression for the velocity of the precipitate boundary under irradiation.
- ✓ According to the model, this velocity increases with increasing the production rate of point defects and temperature.
- ✓ The model allows a good fit to experimental data [I. Monnet et al. JNM (2004) 335, 311] on dissolution of the MgO-based precipitates in the ferritic ODS steel EM10 under 1 MeV electron irradiation.

Reference:
A. Borisenko. J. Nucl. Mater. 410 (2011) 69