TM on “Primary radiation Damage: from nuclear reactions to point defects “

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Annex by

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1. Specific aspects of insulators

- What do we normally need in insulators ?

  → Fusion Diagnostics and H&CD

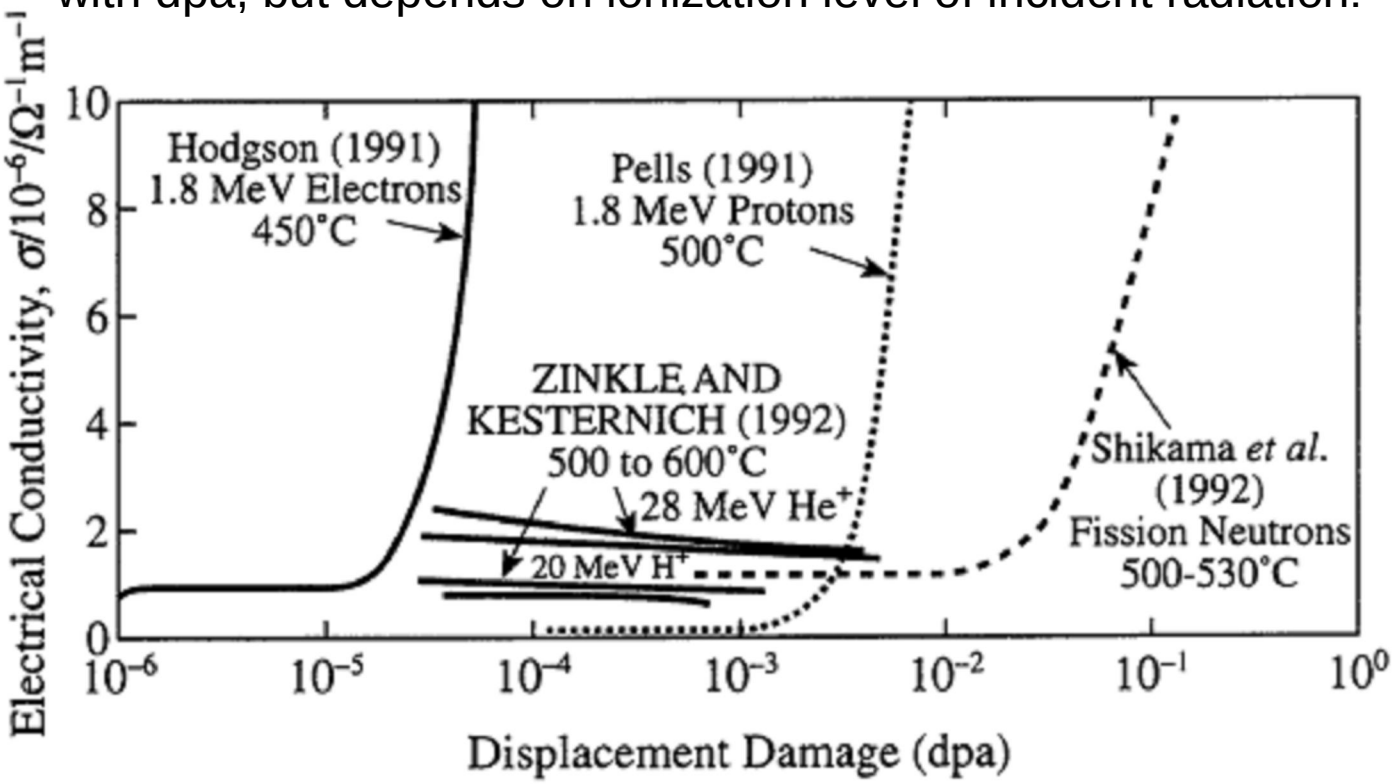
- Very specific properties: Electrical, optical, HF dielectric properties, coatings….
- Normally these properties degrade long before mechanical integrity is an issue.

Two Examples

- Electrical conductivity:
  - → prompt effect (RIC)
  - → degradation (RIED)

Dpa vs Grays in insulators

RIED (Radiation Induced Electrical Degradation) does not scale at all with dpa, but depends on ionization level of incident radiation:



From electrons (higher ionization) → to neutrons (lower)

e-h creation: “A primary defect creation”
→ it’s a matter of IONIZING level

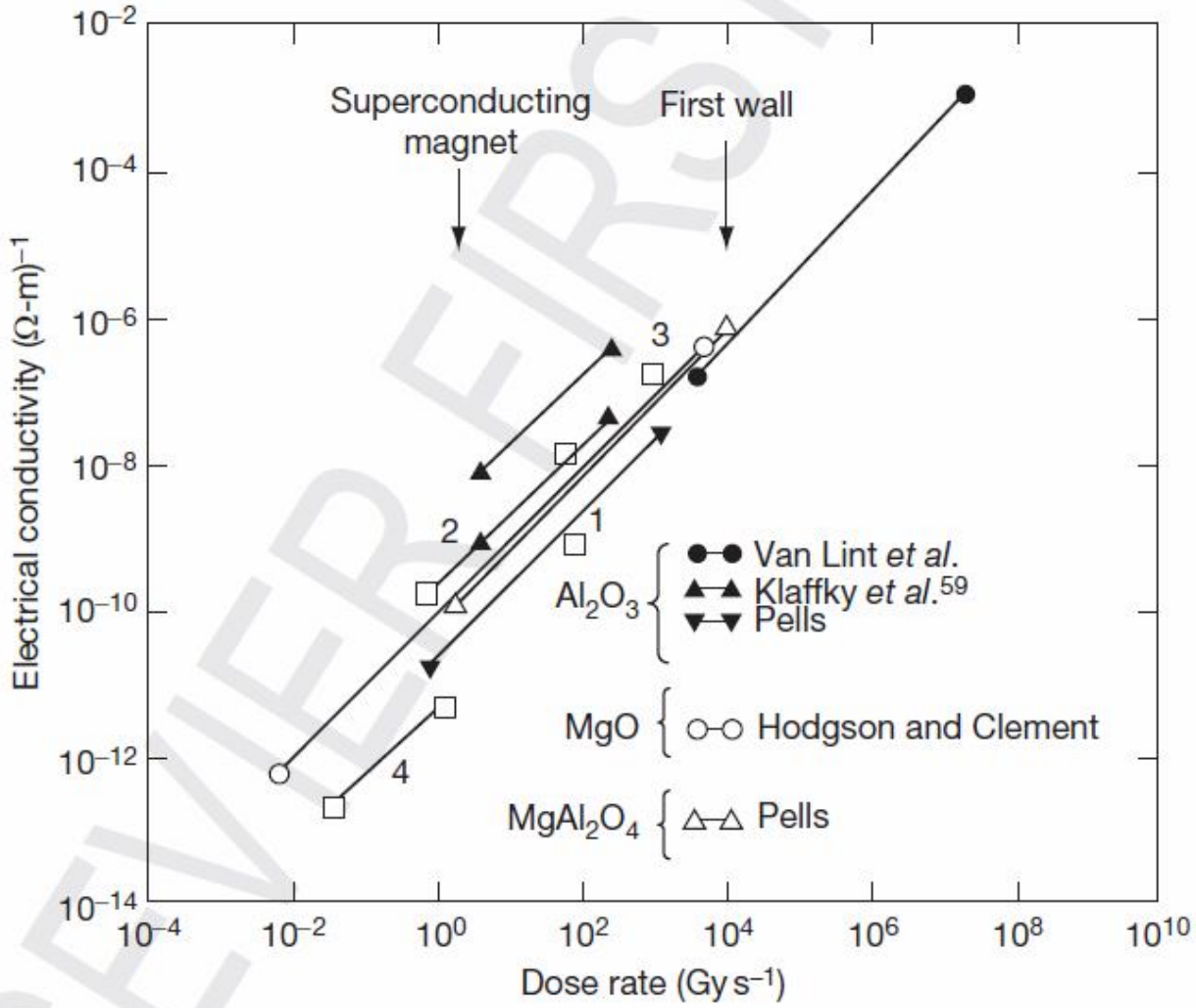


Figure 3 Representative data for RIC as a function of dose rate for different oxide materials. Irradiation with electrons, protons, and neutrons. Reproduced from Shikama, T.; Pells, G. P. *J. Nucl. Mater.* **1994**, *212–215*, 80.

Materials List - Nuclear Data

* Main interest at this precise moment:
  - Al_2O_3 - SiO_2
  - SiC - BeO
  - C (diamond windows) - …
- Secondary materials:
  - AlN, SiN - CaO, Er_2O_3
  - Si , Ge, ZnSe (IR windows)
  - $MgAl_2O_4$ - …

Swift heavy ions (Se>1-10 keV/nm) can introduce new physical phenomena in metals compared to conventional particle irradiations → Avoid for experiments

Material	Thermal conductivity (W/m-K)	Threshold $dE/dx)_e$ for ion track damage
$MgAl_2O_4$	20	8 keV/nm
β-Si_3N_4	29	15 keV/nm
Al_2O_3	32	~20 keV/nm
AlN	177	>34 keV/nm
SiC	350	>34 keV/nm
U_3Si		19 keV/nm [Hou 2003]
UO_2		22-29 keV/nm [Matzke 2000]

Compilation By S.Zinkle