Electronic Supplementary Information (ESI): Nanoporous amorphous Ge-Si alloys – unraveling the physics behind ion beam induced morphogenesis

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Table S1: Literature survey of ion irradiation induced swelling in Ge. "c" and "a" relate to the initial phase (crystalline / amorphous) of the sample.

Ref.	Starting phase	Ion	Energy / keV	Fluence / cm^{-2}
1	c	Bi	280	$4 \cdot 10^{15}$
2	c	Kr	3500	$2 \cdot 10^{14}$
3	c	Bi	30–60	$5 \cdot 10^{13}$ - $1 \cdot 10^{17}$
4	c	Bi	20–30	$5 \cdot 10^{14}$ - $1 \cdot 10^{17}$
5	c	Bi	2–30	$2 \cdot 10^{17}$
6	a	Ar	3	$5 \cdot 10^{15}$
7	a	Au	185000	
8	c	Bi	90–280	$4 \cdot 10^{14}$ - $1 \cdot 10^{16}$
		In	120	$5 \cdot 10^{14}$ - $1 \cdot 10^{16}$
9	c	Ni	165000	$1 \cdot 10^{13}$ - $1 \cdot 10^{15}$
		I	185000	$1 \cdot 10^{13}$ - $1 \cdot 10^{15}$
		Au	266000	$1 \cdot 10^{13}$ - $1 \cdot 10^{15}$
10	c	Xe	5	$1 \cdot 10^{13}$ - $6 \cdot 10^{16}$
11	c	Bi	710000	$1 \cdot 10^{11}$ - $1 \cdot 10^{12}$
		U	1300000	$5 \cdot 10^{10}$
12	a	Kr	700-1800	
13	c	Mn	100	$2 \cdot 10^{16}$
14	c	Ga	30	$5 \cdot 10^{12}$-$5 \cdot 10^{14}$
15	a	Au	185000	
16	a	Ge	300	$1 \cdot 10^{15}$ - $4 \cdot 10^{16}$
17	a/c	Ge	300	$1 \cdot 10^{16}$
18	c	I	3000–9000	$5 \cdot 10^{11}$ $1 \cdot 10^{17}$
		Ag	2500	$1 \cdot 10^{15}$ - $5 \cdot 10^{16}$
		Au	4500	$1 \cdot 10^{15}$ - $8 \cdot 10^{16}$
19	c	Ge	1000	$6 \cdot 10^{15}$ $1.3 \cdot 10^{17}$
20	c	Kr	1500	$8.5 \cdot 10^{12}$ - $2.7 \cdot 10^{16}$
21	c	Ge	30–400	$2 \cdot 10^{15}$ - $1 \cdot 10^{17}$
22	c	Ga	100	$3 \cdot 10^{15}$ - $4 \cdot 10^{17}$

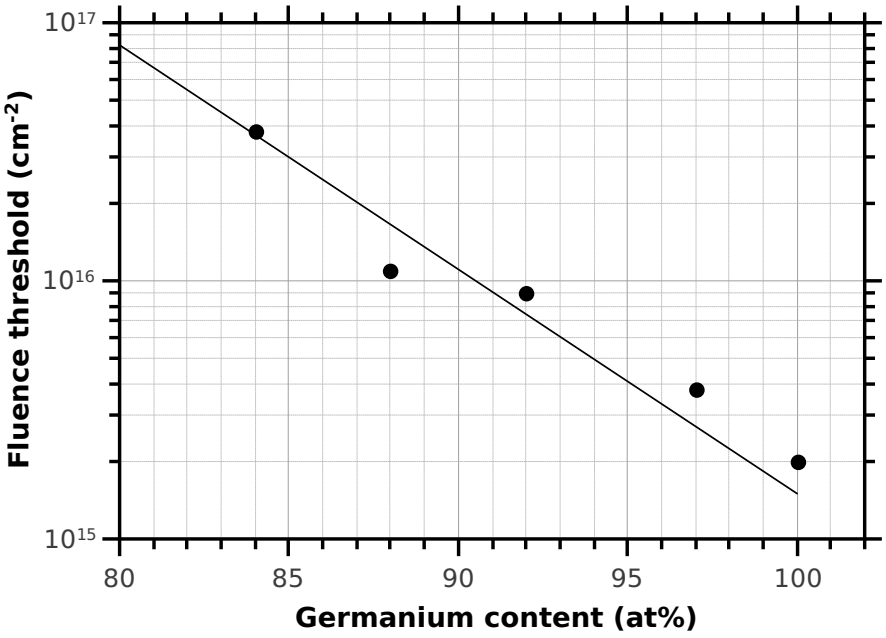

Figure S1: Experimentally determined threshold fluence for swelling in Ge-Si samples during 30 keV Ga^+ ion treatment. An increase with increasing Si content is observable. The line merely serves as guide to the eye.

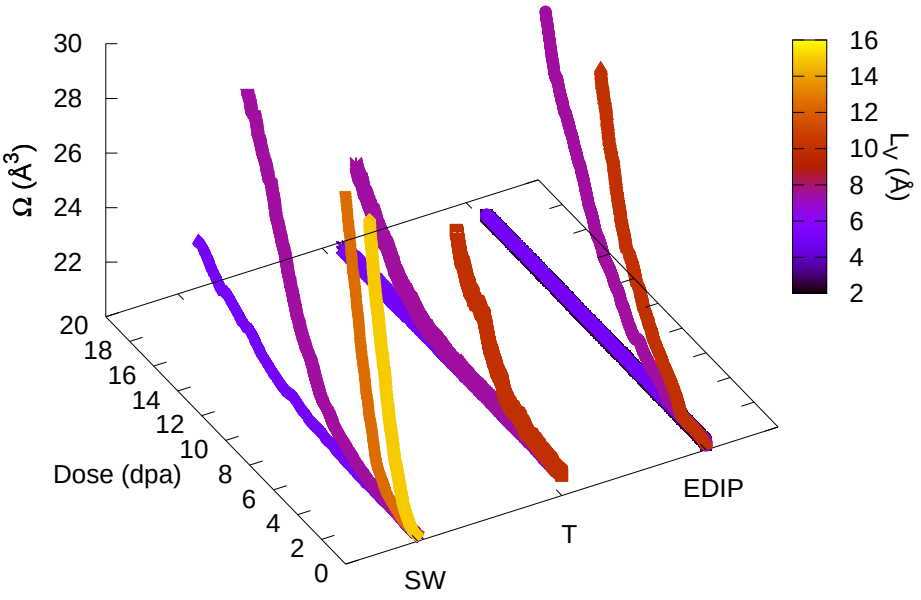

Figure S2: Change of atomic volume, Ω, during insertion of Frenkel pairs into initially single crystalline SW-, T- and EDIP-Si at 1000 K, 2100 K and 1000 K, respectively, employing different vacancy relaxation distances, L_V. While the temperature was chosen to ensure absence of amorphization reactions throughout, a transition from a non-swelling to swelling regime is observed with increasing L_V for all Si models. A snapshot of a representative atomic configuration, including pore and defect structure, is shown in Fig. S3. For all potentials radiation induced fluidity under these conditions was determined employing the approach described within the manuscript, yielding values close to zero. Once sinks for point defects have been generated (cavities, dislocation loops), minor contributions originate from a Coble-style[23] creep.

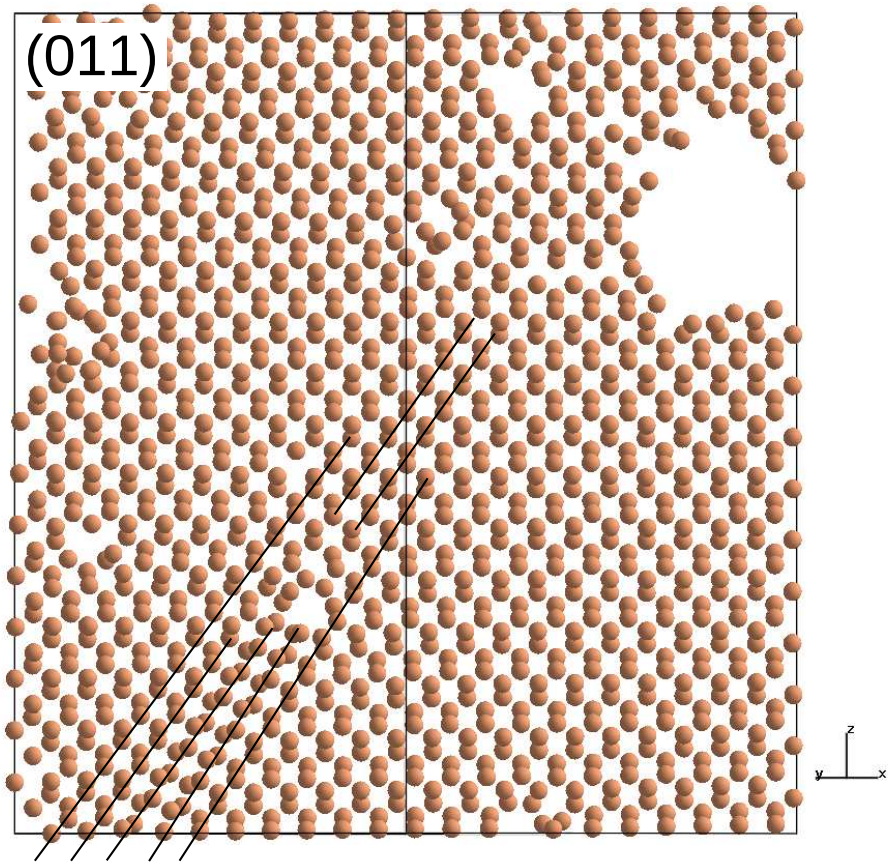

Figure S3: Exemplary snapshot of pore / defect morphogenesis in fully crystalline T-Si at a dose of 15 dpa and $L_V = 7.5$ nm in the (011) bilayer plane-crossectional view. Due to a sufficiently high mobility of vacancies and interstitials, "vacancy clusters" (pores) and "interstitial clusters" (dislocation loops) are generated. Aggregation to dislocation loops occurs within the {111} planes as bilayered stacking fault, as indicated by the lines and bounded by dislocation lines. The simulation runs employing SW- and EDIP-Si yield comparable results, if comparable levels of swelling are observed in Fig. S2. The orientation of the dislocation loop is in agreement with experimental observations ("swirl defects" in Si)[24] and computational results using *ab-initio* methods[25].

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