**Germanium, Round 2**

*Space group*: Fd-3m, 227

*Lattice vectors*: *R*1 = (-*a*/2, 0, *a*/2); *R*2 = (0, *a*/2, *a*/2); *R*3 = (-*a*/2, *a*/2, 0)

*Atom positions*: Ge1 = (0, 0, 0); Ge2 = (*a*/4, *a*/4, *a*/4)

*Isotopes*: 20.38% 70Ge (69.924 amu); 27.31% 72Ge (71.922 amu); 7.76% 73Ge (72.923 amu); 36.72% 74Ge (73.921 amu); 7.83% 76Ge (75.921 amu)

*DFT*: Use VASP or QE. PBEsol PAW, no *d* states in valence   
(QE: Ge.pbesol-n-kjpaw\_psl.1.0.0.UPF; VASP: standard version with sol flag)

*Warning: DFT may give metallic. May need to check convergence with electronic smearing.*

**Checklist** (*all data should be reported for the 2-atom primitive cell*)

* Please provide all computational costs in cores\*hours

***Structure***

* Converged relaxed ‘temperature (T)=0’ lattice constant *a* (target accuracy < 0.005 Å)

- Single value with 4 significant figures: X.XXX

* Methods / convergence criteria

- Energy/force thresholds

- Thresholds/ Integration mesh / grid shifting

- Fermi band shift

- Smearing

* Other notes / cpu hours (*e.g., multiple relaxations, compilers, hardware*)
* All input files to run fully converged calculations (*e.g., qe.sc.in, POSCAR*)
* Other notes / cpu hours
* All input files to run fully converged calculations

***Electrons***

* Due to all teams reporting essentially the same results in Round 1, we are not requesting any information about the electronic band structure in Round 2.

***Harmonic***

* Converged dispersion (target accuracy < 0.1 THz for Γ/X/L frequencies)

- Numerical data: normalized wavevectors (q) and frequencies (f) for 6 polarizations (*j*) (excel or text file)

- q in units of 2π/*a* and f in THz (f=ω/2π)

- 3 segments: Γ→X, Γ→K→X, and Γ→L evenly divided with ~100 q points per segment

- 3 files, one for each segment. For each scaled q from 0 to 1 list (~100 rows): q, f1, f2, f3, f4, f5, f6

- Converged phonon density of states (method, width, grid density sampled)

* Converged harmonic interatomic force constants (IFCs)

- Supercell perturbations or DFPT (provide relevant details)

- Standard format for code used (*e.g.*, QE, Phonopy)

- Will be supplied as supplemental material upon publication

* Methods / convergence criteria

- Thresholds

- Supercell size / integration mesh

- Symmetries / irreducibility / number of calculations (*linked to cpu hours below*)

- Post-processing (*e.g., enforce invariance constraints*)

* Evidence of converged dispersion

- Dispersions with varying supercell sizes and integration meshes

* Other notes / cpu hours (*e.g., accuracy vs cpu cost, shifted meshes*)
* All input files to run fully converged calculations

***Anharmonic thermal transport***

* Converged isotopically pure (100% 70Ge (69.924 amu)) thermal conductivities (*k*) (target accuracy <2% difference between successive grids – please contact us if a problem) for T=20 K and T=300K: *kpure,full* and *kpure,RTA*. If only RTA available, then only *kpure,RTA*

- Evidence of convergence with varying integration meshes

* Four temperature-dependent thermal conductivity data sets using integration mesh from 300K convergence above: natural isotopes with full BTE solution (*knat,full*), natural isotopes with the relaxation time approximation (RTA) (*knat,RTA*), isotopically pure (100% 70Ge (69.924 amu)) with full BTE solution (*kpure,full*), and isotopically pure with RTA (*kpure,RTA*). If only RTA available, then only *knat,RTA* and *kpure,RTA*

- Do not include boundary scattering, even at low T. We want to see how the codes behave at low T without this extrinsic scattering.

- Numerical data: T (K) and *k* (W/m/K) in range 20K < T < 1000K (excel or text file)

- For 20K ≤ T ≤ 50K increments of 10K (4 data points); for 50K < T ≤ 300K increments of 25K (10 data points); for 300K < T ≤ 1000K increments of 100K (7 data points).

- 1 file with T from 20K to 1000K list (21 rows): T, *knat,full*, *knat,RTA*, *kpure,full*, *kpure,RTA*

* Accumulated T=20K and T=300K *kacc* vs frequency and *kacc* vs mean free path (mfp) for *knat,RTA* and *kpure,RTA* using the converged q-grids at each temperature.

- Numerical data for each mode (q, *j*) sampled in the Brillouin zone integration: f (THz), mfp=|sqrt(*vx*2+*vy*2+*vz*2)×lifetime| (nm), mode contribution to *k* (W/m/K) for *knat,RTA* and *kpure,RTA*

- 1 file (excel or text) with row for each mode (q, *j*): f, mfp, mode contribution to *k*

* RTA T=20K and T=300K three-phonon scattering rates (1/*τ3ph*) and phonon-isotope scattering rates for natural abundance (1/*τiso*) using the converged q-grids at each temperature

- Numerical data: f (THz), 1/*τ3ph* (THz=1/ps), and 1/*τiso* (THz)

- 1 file (excel or text) with row for each mode (q, j): f, 1/*τ3ph*, 1/*τiso*

* Converged third-order anharmonic IFCs

- Standard format for code used

- Will be supplied as supplemental material upon publication

* Methods / convergence criteria: thermal conductivity

- Delta function representation (*with details; e.g., adaptive smearing, cutoff*)

- Integration grid

- Symmetries used

* Methods / convergence criteria: anharmonic IFCs

- Cutoff radius, supercell size, integration mesh, thresholds, displacement parameter for supercell derivatives

- Post-processing

* Other notes / cpu hours
* All input files to run fully converged calculations