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AMSE502 Phase Transformations

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1. The rate of nucleation of solid tin from its liquid has been determined at various temperatures below the melting point by rapidly supercooling a large number (10^{10}) of small tin droplets, separated by an oxide film and measuring the change in volume of the sample as a function of time. Using "bulk" values of the free energy of transformation, ΔG_v, the investigators were able to show that the theory of homogeneous nucleation agreed well with their work and that assumptions of a spherical nucleus and the applicability of the bulk value of the surface energy γ to nucleus formation were correct to within the accuracy of their experiments.

   Calculate the values of the following quantities at 113 ºC
   (a) The liquid-solid interfacial energy for tin;
   (b) The critical radius for the nucleation of solid tin;
   (c) The number of tin atoms in a nucleus of critical size.

   Data
   · The slope of ln *I* versus 1/T at 113 ºC ＝ -23.8×10^3 k
   · ΔG_v at 113 ºC ＝ -10^8 Jm^{-3}
   · radius of tin atom, *r* ＝ 1.5×10^{-10} m
   · Boltzman constant, k ＝ 1.38×10^{-23} J/K

2. The following figure illustrates a nucleation of a completely faceted cubic particle on a flat substrate. Find the critical size (h^*, l^*) and energy barrier of nucleation.