

SE104 Homework 6

1. Iron may exist in either BCC or FCC phase, depending on the pressure and temperature. Calculate (a) the density of the BCC phase and (b) the density of the FCC phase. The atomic radius of iron is 0.14 nm (1 nm = 10^{-9} m); the atomic mass of iron is 55.84 g/mol. (c) What is the effective mass density of a single iron atom? (d) By using these calculation results, derive the packing fractions of BCC and FCC unit cells. Hint: Packing fraction is defined as the percentage of space occupied by atoms in a unit cell.
2. The modulus of elasticity of a steel is 211 GPa, and its Poisson's ratio is 0.28. Calculate its shear modulus and bulk modulus.
3. Find (a) a material with the Poisson's ratio close to 0, and (b) a material with the Poisson's ratio close to 0.5. Briefly explain why these materials have such properties.
4. A composite material is formed by glass fibers and polyester matrix, with the stiffness being 900 GPa and 3 GPa, respectively. The volume fraction of the fibers is 60%. What is the range of possible stiffness of the composite material?
5. A foam is defined as a solid material containing empty cells. Its porosity is defined as the volume fraction of the empty cells. For a given foam, it is measured that if the porosity decreases by $1/3$, the foam stiffness would increase by 4 times. What is the initial porosity? (Hint: $\frac{\tilde{\rho}}{\rho_s} = 1 - p$, where p is porosity, $\tilde{\rho}$ is the density of foam, and ρ_s is density of solid)