1) The optimal compositions of many commercial glasses (such as window pane glass) are close to the ternary $16Na_2O{\cdot}10CaO{\cdot}74SiO_2$. Assuming that the constraint number given by $2.5r$-3 holds for all constituent atoms (including modifiers such as Na and Ca†), determine the mean coordination number of this glass composition using the topological constraint theory and justify the choice of this composition.
† A more accurate description of the constraint number in soda-lime glass based on molecular dynamics modeling can be found at: Laurent *et al.*, *J. Phys. Chem. B* **118**, 12750-12762 (2014). Their result is quite close to our somewhat oversimplified assumption here.

2) Consider a soda lime glass composition $16Na_2O{\cdot}10CaO{\cdot}74SiO_2$ (atomic fraction) made from a mixture of sand [SiO_2], trona [$Na_3H(CO_3)_2{\cdot}2H_2O$], and lime [$CaCO_3$]. If we want to make 1 kg of the glass, how much of each raw material is needed?
Hint: The amount of metal ions is conserved in the glass making process.

3) Apply Zachariasen's rules to the compound BaO. Do you think it is a good glass former?

4) Consider a 2-D solid where atoms are confined within a plane. Derive the rigidity percolation threshold (isostatic condition) to form a critically connected 2-D glass network.

3.071 Amorphous Materials

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