HW 1 Solution

1-7

Solution:

Springs are intended to resist high elastic forces, where only the atomic bonds are stretched when the force is applied. The silicon nitride would satisfy this requirement. However, we would like to also have good resistance to impact and at least some difficulty (in case the spring is overloaded) to assure that the spring will not fail catastrophically. We also would like to be sure that all springs will perform satisfactorily. Ceramic materials such as silicon nitride have a virtually no ductility, poor impact properties, often are difficult to manufacture without introducing at least some small flaws that cause to fail even for relatively low force. The silicon nitride is NOT recommended.

1-14

Solution:

In order to produce an aluminum matrix composite material with a density of 1.5 g/cm^3, we would need to select a material having a density considerably less than 1.5 g/cm^3. While polyethylene's density would make it a possibility, the polythene has a very low melting point compared to aluminum; this would make it very difficult to introduce the polyethylene into a solid aluminum matrix.

One approach, however, might be to introduce hollow glass beads. Although, ceramic glasses have densities comparable to that of aluminum, a hollow bead will have a low density. The glass also has a high melting temperature and could be introduced into liquid aluminum for processing as a casting.

2-7

Solution:

(a) $$\frac{(2000lb)(454g/lb)(6.02\times10^{23}\,atom/mol)}{55.847g/mol} = 9.79\times10^{27}\,atoms/ton$$

(b) $$\frac{(1mol)(10.81g/mol)}{2.3g/mol} = 4.7cm^3$$

2-29

Solution:

Since a composite is subjected to high forces and large temperature changes, many design parameters must be considered, including the length, diameter, orientation of fibers, the properties of matrix, and the interfacial bonding between the fibers and the matrix. In general, we would like to have a strong interfacial bonding in the case of MMCs (Metal Matrix Composite) that uses high stiffness and load-bearing fibers.

A very important factor in regard to reinforced composite compatibility has to do with the mismatch between the coefficient of thermal expansion of fibers and that of matrix. The thermal mismatch can lead to thermal stresses large enough to cause plastic deformation in a soft metallic matrix. Plastic deformation in metallic matrix leads to the introduction of defects such as vacancy, crack etc.