linkages. Since metallic bonds are non-directional, slip processes occur easily in the directions of closest atomic packing; planes of high atomic density slide past each other under the application of small shearing forces. The interatomic metallic linkages reform as easily as they are broken. Hence, γ_2 has considerably lower bulk, shear and Young's moduli than the other two alloys.

Possible Phase Transitions

Many materials are able to transform from one crystalline form to another when hydrostatic pressures are applied. These transformations, when they occur, always occur with the structure changing to one of higher density with increase in pressure.

γ–Ag_3Sn

The slope changes in the elastic constants and the ultrasonic velocities of Ag_3Sn may imply that some type of pressure dependent volume change may be occurring in the range of 20–30 kb. Since the gasket and frictional effects take up most of the applied force, a considerable increase in force is required to compress the gaskets when the sample undergoes a discontinuous volume change. This effect spreads the volume transition over a range of applied force or apparent pressure. For this reason, it is not possible to determine the exact transition pressure with this apparatus. An examination of the structure of Ag_3Sn using a high pressure x-ray diffraction apparatus is planned to see whether a phase transition is actually occurring.

Bridgman[6] (1935) has examined the compressibilities of several intermetallic compounds as a function of pressure. The striking characteristic in his data is the large number of volume discontinuities detected and the observance of such irregularities as creep and hysteresis. This behavior is expected since intermetallic compounds are not strict chemical compounds. Often large superstructures are formed since the interatomic linkages are not as strong as true chemical bonds. Since γ–Ag_3Sn has an orthorhombic superlattice, formed from a slightly deformed hexagonal close packed structure, there is a possibility that the structure returns to the hexagonal close packed lattice at high pressures. A detailed x-ray determination of structure at high pressures will be necessary to fully determine the characteristics of the transition if a structure change is taking place.

There is also a possibility that the transition reflects an electronic rearrangement. Murphy[7] reported that γ–Ag_3Sn undergoes a transformation at about 60°C at atmospheric pressure and that the nature of the transformation was not known. Preston[8] showed by x-ray diffraction methods that the lattice did not change during this transition.

γ_2–$HgSn_{7-8}$

The transformation suggested in the γ_2 data appears to occur in the range 15–20 kb. Although an x-ray diffraction study of the structure at high pressures is necessary to determine whether the structure actually changes, structural transitions can be suggested from the work of Raynor and Lee.[9]

γ_2 is a tin-rich solid solution. Raynor and Lee have shown how the simple hexagonal lattice of γ_2 could be formed from the body-centered tetragonal lattice of tin when solute atoms of very similar diameter are added. The structure can be derived by drawing the hexagonal structure in terms of an orthorhombic cell and by stacking three such unit cells on top of each other. The atoms of this structure lie on two inter-penetrating, body-centered, orthorhombic sublattices. If one sublattice is moved in the direction of the "a" axis by an amount "a"/4, a contraction along the "c" axis can occur, resulting in the tin type of structure. During this transformation, the (01.1) and (10.1) planes of the hexagonal structure become the (220) and (121) planes of the tetragonal structure. Since the Brillouin Zone of white tin is formed by the (220) and (121) planes,[10] the formation of γ_2 may be due to the tendency of these (220) and (121) planes to equalize their interplanar spacings when mercury is added, resulting in a decrease in the electron: atom ratio. At high pressure, further change may occur.

Conclusion

Measurement of the elastic constants of the constituent alloys of dental amalgam has shown that the bulk, shear and Young's moduli of the γ_2–$HgSn_{7-8}$ phase are considerably lower than the elastic moduli of γ–Ag_3Sn and γ_1–Ag_2Hg_3. Consequently, the elastic response of dental amalgam to applied forces will be influenced by the presence of the γ_2 phase. These lower elastic moduli are produced by the weak intermetallic forces bonding the mercury and tin