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THE COMPRESSIBILITY OF SOLID NOBLE GASES AND THE ALKALI METALS AT 0°K

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Abstract—The compressibilities of the solid noble gases at 0°K (and 0 pressure) were calculated from their experimental and theoretical compressions ($\Delta V/V_0$). They are compared with the experimental values of the compressibilities of the alkali metals, also at 0°K. The compressibilities of the noble gases follow an unusual pattern, different from all other families in the Periodic System, the latter being essentially proportional to the atomic volume and therefore the atomic number of the element. Solid helium is by far the most compressible element, to be followed by solid neon; on the other hand Kr, Xe and Em are *substantially less compressible* than the alkali metal directly following them. Finally, Ar has practically the same compressibility as K (see Fig. 1).

RICHARDS[1] determined the compressibility of many elements and first pointed out that compressibility is a strongly periodic function of their atomic weight (or number). It was, however, BRIDGMAN who made the greatest experimental contributions in this field and who measured the compressibilities of over 50 elements. In his book *The Physics of High Pressure*,[2] which is now a classic, he discusses the wide range of compressibilities of the elements from diamond to cesium. He states[3]: "The most important gap in the results is in the compressibilities of the rare gases, none of which are known in solid form. The direct experimental determination of these would be difficult, because of the necessity for making the measurements at low temperatures; we have seen, however, that measurements of gaseous H_2 and He enable lower limits to be set to the compressibilities of the corresponding solids, and that the probable compressibilities are very high, in fact much higher than that of any of the elements shown in the figure*. *It seems almost certain that the positions of greatest compressibility in the completed diagram will be occupied by the solid rare gases, instead of the alkali metals as at present.*"

He says further[4]: "The great range of numerical values of compressibility is striking, the range of C to Cs being by a factor of 240; the variation would be much greater if the compressibility of the solidified rare gases were known." BRIDGMAN has shown[5] that by plotting compressibility in a group of elements of the periodic

* The figure is the one showing the RICHARDS relationship between the compressibility of the elements plotted vs. their atomic number (similar to our Fig. 1).

(1) T. W. RICHARDS, *J. Amer. Chem. Soc.* **34,** 971 (1912); **37,** 1643 (1915); **46,** 1419 (1924); **48,** 3063 (1926); **50,** 3290, 3304 (1928).

(2) P. W. BRIDGMAN, *The Physics of High Pressure* (1st. Ed) Bell, London (1931); reprinted (1949).

(3) P. W. BRIDGMAN, *The Physics of High Pressure* (1st. Ed) p. 165, Bell, London (1931); reprinted (1949).

(4) P. W. BRIDGMAN, *The Physics of High Pressure* (1st. Ed) p. 166, Bell, London (1931); reprinted (1949).

(5) P. W. BRIDGMAN, *The Physics of High Pressure* (1st. Ed) p. 167, Bell, London (1931); reprinted (1949).