

vacuum of the order of 10^{-4} mm of mercury on to KCl single crystal substrate maintained at room temperature, and were annealed for a few hours after evaporation to ensure the homogenization of the alloys. The thickness of the films varied from 200 Å to 500 Å. The electron diffraction pattern of Cu_2Se alloy is shown in Fig. 1a. Examination of the diffraction pattern of the alloy showed face-centred cubic structure but on heating the alloy the transformation in structure could not be observed even up to 300°C .

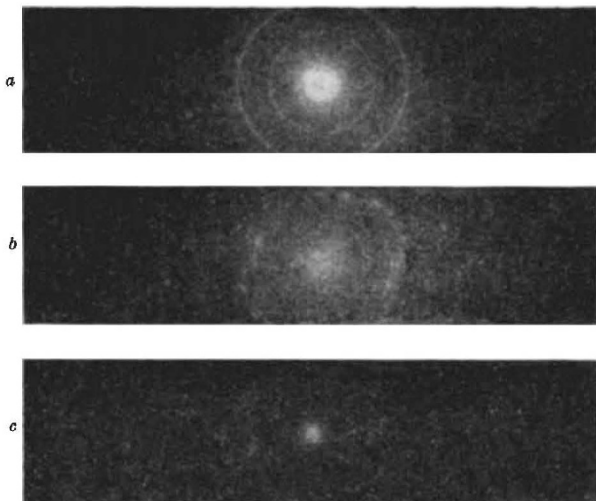


Fig. 1. Electron diffraction patterns of: a, Cu_2Se alloy thin film at room temperature; b, Ag_2S alloy thin film at room temperature; c, transformed phase of Ag_2S alloy thin film

The diffraction pattern of Ag_2S alloy thin film is shown in Fig. 1b. Examination of the patterns showed that the room temperature structure of the alloy is orthorhombic with lattice spacings agreeing with the bulk values. When the films were heated inside the diffraction unit, it was observed that the structure transforms to body-centred cubic at a temperature of 218°C . Fig. 1c shows the transmission electron diffraction pattern of the transformed structure of Ag_2S . The films were cooled inside the diffraction unit under vacuum at the rate of $2^\circ\text{C}/\text{min}$ and the diffraction patterns were recorded while the temperature was decreasing. It was found that the original structure was retained at a temperature of 156°C ; that is, the films showed the phenomenon of hysteresis.

From the above observations it can be concluded that in thin films the temperature of structural transformation is increased to that observed in the bulk state.

The results with Ag_2S also confirm my earlier observations⁵⁻⁷ and those of others^{8,9}. The phenomenon of hysteresis similar to that observed in Ag_2S alloy thin film has already been reported in the case of Ag_2Se and Ag_2Te alloy thin films^{6,7}. Paparoditis¹⁰ has also observed the phenomenon of hysteresis in Ag_2Te (in the bulk state) by electrical conductivity measurements.

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Hydrogen: a Very Light Member of Group IVb

THE data presented by Dash¹ in a recent article relating hydrogen to the halogen series could well be used to show a similar relationship to the carbon family: with hydrogen as with the elements of Group IVb the valence shell is exactly half filled (or half empty), and hydrogen has the highest boiling point in its horizontal row of the Periodic Table. Furthermore, its electronegativity is very close to the electronegativities of the carbon group elements.

One need not stop here—by judiciously choosing specific properties of hydrogen, this element can be likened and related to any desired element or family of elements in the Periodic Table, if it is felt necessary or desirable to do so. It should be possible to do this without resorting to the procedure of comparing the slopes of lines drawn on a graph of atomic radius versus electron position, in which atomic radius is represented by the covalent radius for some elements and by the van der Waals radius for others.

Unfortunately it has become common in many textbooks to state the 'atomic size' of members of the rare gas family in terms of their van der Waals radii (the only one conveniently measurable) while for other elements covalent or metallic radii are used. This may lead to the erroneous concept of the rare gas atoms appearing to be considerably larger in size than the atoms immediately preceding them.

It is unfortunate that the thesis of the previously cited article is based largely on this fallacy.

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¹ Dash, H. H., *Nature*, **202**, 1001 (1964).

IN reply to Prof. Hawes's comments on my earlier communication¹, I would like to state that the only logical position for hydrogen in the periodic system of elements is $1s^1$ as based on quantum mechanical considerations. My communication clearly made this point. The relationships and regularities shown by the atomic radii and boiling-point graphs are functions of atomic structure. While such properties reveal the periodic nature of atomic structure, it nevertheless remains a fact that they are a consequence of the structure and not vice versa as Prof. Hawes seems to imply.

The sources for the data were explicitly given. Only those radii cited for the atoms in the uncharged state were used in plotting the graphs. They should thus all be representative of covalent radii. In any event, even if the radii of a given series like the rare gas elements represent van der Waals radii, since these elements do not form homopolar covalent aggregates, the nature of their periodic relationships would remain unchanged so long as such radii were used for the entire series of rare gas elements. That this is so is quite evident from the graph shown in my communication in which the uniqueness of the first quantum shell is quite apparent. This same uniqueness would continue to remain apparent regardless of any reasonable correction that could be applied to the radii of the rare gas elements to bring them more into line with a covalent picture.

I am sure Prof. Hawes would not wish to dispute the fact that hydrogen does form a stable negative ion (H^-) similar to the halide ions. It is well known that the alkali hydrides are salts, conduct current in the fused state, and liberate hydrogen at the anode. This similarity of hydrogen to the halides is explainable on the basis of atomic structure, and substantiates the main thesis of my communication, the uniqueness of the $1s^1$ position.

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¹ Dash, H. H., *Nature*, **202**, 1001 (1964).