the photographs 90°, and then drawing the resultant total displacement. The axes may be chosen so that displacements perpendicular to (Mode I) and parallel to (Mode II) the crack direction may be directly resolved, with the resultant giving the weighting of the combination of the two opening modes and the material rotations which occur as the crack tip opens. The displacements associated with hysteresis (using two photographs made at the same load magnitude, but one made during loading, and the other during unloading) may also be measured using this stereo viewing technique. The reader is encouraged to reproduce Fig. 1, cut out the photographs and try the stereo viewing technique for himself to see the effects described above.

In summary, the simple technique described for observing displacements at crack tips by stereo viewing offers the following possibilities:

(1) Measurement of displacements at high resolution very close to the crack tip;

(2) Derivation of crack tip strain magnitudes;

(3) Division of displacements into those related to Mode I and Mode II loading;

(4) Measurement of hysteretic displacements due to cyclic loading;

(5) Measurement of the hysteretic, or cyclic, and total plastic zone size and shape due to cyclic loading with and without hold times.

All the above information may also be derived from replicas, either positive or negative as made by a variety of techniques, and photographed in the transmission or scanning electron microscopes, or it may be determined by directly loading the specimen in the SEM. The only limitation now known for the technique is that it allows crack tip deformation information to be determined only at the specimen surface, which is a limitation of most other techniques as well. Electron channelling and etching, however, may be used to measure interior plastic zone parameters, for some materials, on metallographic cross-sections [3, 7].

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Experiments on the stoichiometry of UCo_2

Several preparations of this cubic Laves phase have been made in the course of investigations principally concerned with measurements at low temperatures. The physical property data obtained are presented and discussed elsewhere [1]. The purpose of this note is simply to record some interesting features of their preparation and characterization. The experimental variable was the Co/U ratio. The values of the ratio quoted below are probably not of fundamental significance since the true stoichiometric ratio will probably differ slightly from nominal owing to impurities in the source metals and losses in preparation. However, special care was taken to keep preparation conditions constant as far as possible, so that *relative* values of Co/U are significant.

Samples weighing approximately 1.5 g were made by arc-melting together high-purity cobalt and uranium (Johnson Matthey "Specpure" grade), and casting attempted by the suction-casting process [2, 3], using a mould with cylindrical cavity 1.6 mm in diameter and 18 mm high. At this point, marked variability in fluidity was noticed, such that casting was difficult or impossible near a Co/U ratio of 1.98. Further observations of partial running of the alloy (Fig. 1) indicated that a critical composition occurred at a Co/U ratio between 1.97(5) and 1.98(0). This ratio coincided, within the limits of experimental error, with a

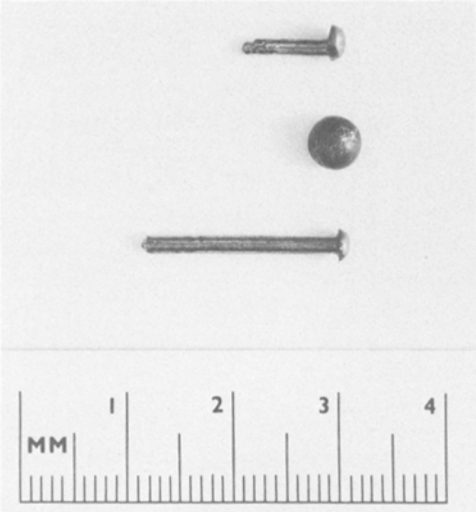

Figure 1 Illustrating attempts to cast UCo_2 of various nominal stoichiometric ratios into a 1.6 mm diameter copper mould. Left to right: Co/U = 1.98(0), 1.97(5) and 1.96(4) respectively.

maximum (cusp point) on a plot of residual electrical resistivity at liquid helium temperatures versus Co/U ratio [1].

Further evidence supporting the existence of a critical composition was supplied from (a) attempts to use an electropolishing method for microsections and (b) microhardness data on the same specimens. It was found that compositions rich in uranium were partly smoothed by the electromechanical technique [4,5] using an electrolyte consisting of 12% sodium thiosulphate and 19% potassium thiocyanate at a current of 20 to 60 mA, whereas cobalt-rich preparations were partly stained, partly corroded under the same conditions, the changeover from one behaviour to another occurring at the same critical ratio as above. Hardness determinations (50 g load, average of three impressions) gave the results in Table I. It will be noted that the values for the 1.98(0) to the 2.03(6) inclusive are on a straight line, so that a break at approximately 1.98 could be construed.

TABLE I

Co/U ratio	1.96(4)	1.98(0)	2.00(0)	2.02(0)	2.03(6)
Hardness ($kg\,mm^{-2}$)	690	770	790	820	850

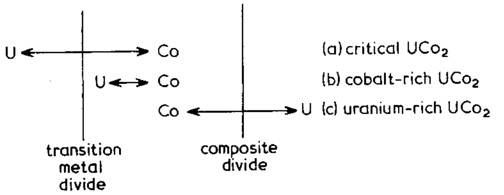

Figure 2 Schematic description of UCo_2 of varying Co/U ratio in terms of a subdivision of the Periodic Table.

The simplest explanation for these results is that at the critical composition we have the nearest approach to covalent (lattice) type of bonding, with electron contributions [6] from the constituent atoms as 4 plus (2 × 2). This would be consistent with an argument one could propose through surface tension and its relation to the perfection of bonding in the liquid globule. The author has pointed out [6,7] that certain alloy systematics are consistent with covalent bonding "across the transition metal divide", and the critical ratio UCo_2 (Fig. 2a) may be an example of this. Perhaps UCo_2 with excess cobalt can be schematically represented as being analogous to a Mn–Co solid solution (Fig. 2b), whilst uranium-rich UCo_2 may be analogous to a Hume–Rothery type system [8] such as Co–Zn.

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