Densities of Liquid and Solid Indium

By D. D. Williams and R. R. Miller

A recent literature survey at this Laboratory revealed a paucity of physical property data on metallic indium. Density values, being of interest to a problem at hand, were determined. The method employed involved more or less standard dilatometric practice. A 32-cc. quartz dilatometer, mercury calibrated, was used as the measuring vessel. The temperature bath consisted of silicone oil contained in a clear Pyrex Dewar flask, with appropriate heating and stirring facilities. Temperatures were controlled by a series of mercury thermoregulators, calibrated to cover a range of temperatures from 25 to 300°. The meniscus level, with respect to a zero line on the capillary of the dilatometer, was determined by differential readings on a cathetometer. These readings were directly interpolated to volumes *via* the mercury calibration of the dilatometer.

The metallic indium was obtained from the A. D. Mackay Company, New York, N. Y. Spectrographic analysis established a purity of 99.98% indium. The principal impurity was iron, with faint traces of nickel, copper and lead.

For liquid densities, the metal was melted under a high vacuum, and entered the dilatometer through a Corning sintered glass filter (medium porosity). A tube, extending from the filter into the main body of the dilatometer, facilitated filling, and prevented wetting of the capillary walls by the metal. To eliminate wetting and superficial oxidation, a layer of paraffin (m. p. 70°), sufficient to cover the surface of the metal, was added. Oxidation of the paraffin, at the higher temperatures, was prevented by maintaining an atmosphere of inert gas in the capillary. Experimentally determined liquid density values are given in Table I.

Table I

Density of Liquid Indium

Temp., °C.	Density, g./cc. Sample A	Sample B
164	7.026	7.027
194	7.001	
228	6.974	6.974
271	6.939	6.940
300	6.916	

The average of these values result in a straight line, the equation for which is

$$d(\text{from } 156.14 \text{ to } 300°) = 7.160 - 0.000813t$$

where t is the temperature in ° C. The experimental points exhibit a deviation from this equation of less than 0.01%. Over-all accuracy is within ±0.2%.

For solid densities, a sample of air-cast indium was cut into small pieces, and inserted into the dilatometer. Void space was eliminated by the addition of sufficient *n*-butyl phthalate to cover the indium and provide a readable meniscus in the capillary of the dilatometer. Residual gases were removed by prolonged evacuation.

Density values were calculated by subtracting the volume occupied by *n*-butyl phthalate, at a particular temperature, from the total volume at that temperature. The difference was the volume occupied by the indium.

Any error due to the possibility of void spaces in the indium chunks was obviated by the following treatments: Run 1 was made on metallic chunks; Run 2 on the same metal after it had been melted and allowed to solidify slowly at the melting point; Run 3 on the same metal after it had been melted and cooled rapidly to room temperature by quenching in water.

Experimentally determined solid density values are given in Table II.

Table II

Density of Solid Indium

Temp., °C.	Density, g./cc. Run 1	Run 2	Run 3
25	7.303	7.306	7.300
70	7.274	7.270	
115		7.239	7.239
150	7.217	7.212	7.214
164 (liquid)	7.025		

Using the method of least squares, the data in Table II give the equation

$$d(\text{from } 25 \text{ to } 156.4°) = 7.321 - 0.000713t$$

where t is the temperature in ° C. The extrapolated value at 20° is in good agreement with literature values.[1,2,3]

Since all volume errors in the method used for solid density reflect on the indium volume, the solid densities show more variation than the liquid densities. However, over-all accuracy is within ±0.2%.

(1) "Mechanical Properties of Metals and Alloys," National Bureau of Standards Circular C447, 1943.

(2) "Metals Handbook," American Society for Metals, p. 78, 1939.

(3) W. A. Roth, I. Meyer and H. Zeumer, *Z. anorg. Chem.*, **214**, 315 (1933).

Chemistry Division
Naval Research Laboratory
Washington 25, D. C.

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NEW COMPOUNDS

Some Mercuri Cyclohexanes

α-1-Iodomercuri-2-methoxycyclohexane.—A solution of 3.49 g. (0.01 mole) of α-1-chloromercuri-2-methoxycyclohexane[1] in 18 ml. (0.015 mole) of 3.3% aqueous sodium hydroxide was added slowly to a stirred solution of 7.5 g. (0.045 mole) of potassium iodide in 20 ml. of water. After several hours 2.6 g. (60% of theoretical yield) of iodomercurial was filtered off (m.p. 76–78°) and crystallized from 3 cc. of hot acetone (m.p. 81–81.4°, wt. 1.95 g.)

(1) J. Romeyn and G. F Wright, This Journal, **69**, 697 (1947).