Solid-Liquid Phase Equilibria in the Sodium-Rubidium Alloy System

By J. Rex Goates, J. Bevan Ott and Chen C. Hsu

Dept. of Chemistry, Brigham Young University, Provo, Utah

Received 27th June, 1969

Thermal methods were used to determine with high precision, the solid-liquid phase equilibria diagram for the sodium-rubidium system. The results differ greatly from those of earlier workers, especially near the eutectic composition where differences in melting points as large as 25 K occur. A search was made for possible intermetallic compounds (especially Na_2Rb). Neither slow temperature cycling in the temperature range where compound formation could occur nor extended periods of annealing just above the eutectic temperature produced any evidence for compound formation. An 8:1 (sodium to rubidium) sample was subjected to 60,000 atm pressure. Again, no evidence was obtained for solid compound formation.

Freezing point measurements have been made by several workers [1-3] on solutions of sodium and rubidium in an attempt to determine the solid-liquid phase diagram for this system. The measurements were made without the advantage of high purity metals, platinum resistance thermometry, and modern inert atmosphere facilities. As a result, the data are in poor agreement, especially on the rubidium-rich side of the eutectic, where few data points were obtained. Comparison of the data available indicated differences in temperature of as much as 15° between the data of Rinck [1] and that of Goria.[2] No evidence was found in any of the previous work for intermetallic compound formation. This seemed surprising since a peritectically melting Na_2K intermetallic compound had been well established in the sodium-potassium system,[4,5] and a sluggishly forming peritectically melting Na_2Cs compound had been reported for the sodium-caesium system.[6,7]

As a part of our investigation of alkali metal mixtures, we sought to obtain a detailed and accurate solid-liquid phase diagram for this system. Of special interest was the possibility for the formation of intermetallic compounds such as Na_2Rb.

EXPERIMENTAL

CHEMICALS

High purity (99.8 % minimum) rubidium was obtained from the Kawecki Chemical Company. Batch analysis of the material by Kawecki Chemical indicated 0.034 mol % Cs, 0.02 mol % K, 0.018 mol % Na, 0.015 mol % Si with negligible amounts of other impurities. Oxygen analysis was not available. However, calculations from the change in freezing point with fraction melted indicated less than 0.02 mol % oxygen. The rubidium is considered to be better than 99.9 % pure.

Reactor Grade sodium was obtained from the U.S. Industrial Chemical Company. Specifications for Reactor Grade sodium limit the impurities to <200 p.p.m. K, <100 p.p.m. Ca, <50 p.p.m. Rb and smaller amounts of other impurities. Comparison of the freezing point of this sodium with our measurements of an ultra-pure sample as described in the literature [5] limits the impurities to <0.05 mol % total.