The Hugoniot Equation of State of Sodium Chloride in the Sodium Chloride Structure*

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ABSTRACT

The Hugoniot equation of state of NaCl has been obtained by measuring the shock velocity through NaCl on copper and 2024 aluminum base plates. Shock velocities through the base plates and standard impedance-matching were used to obtain the Hugoniot curves for both single crystal (in various orientations) and pressed powder samples. The smooth behavior of the resulting shock locus up to 230 kb indicates that NaCl exists in the sodium chloride structure up to this pressure. In the shock-particle velocity plane the best linear fit to the data reported here is u_s (km/sec) $= (3.528 \pm .012) + (1.343 \pm .009) u_p$. A quadratic fit, which gives a large weight to the measured bulk sound speed in NaCl, is $u_s = 3.403 + 1.5422\, u_p - 0.07345\, u_p^2$. Isotherms at 293° K, using different forms for the Grüneisen parameter and a simple Debye model for the specific heat, are calculated from the Hugoniots and are presented here. They should prove useful when NaCl is used as an internal standard in high pressure X-ray devices.

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Introduction

Since Jamieson[1] first used NaCl as an internal pressure standard in his high pressure X-ray apparatus, it has been a serious candidate for a pressure standard in high pressure X-ray work. Decker[2] has advocated the use of NaCl as a standard. His proposal was based on a Born-Mayer equation of state. Parameters were fixed by the initial density and sound speed of NaCl at zero pressure and he achieved a prediction of the curvature of the P-V isotherm, which can be converted in terms of variables familiar to workers in the dynamic-pressure field to a prediction of the slope of the shock velocity vs. particle velocity Hugoniot. His results were supported by the then existing shock wave data. An increase of 1.3 percent in the value of the sound speed he used in his work would bring his isotherm into agreement with the result of the present report.

Objections have been raised[3,4,5] to using NaCl as a standard because of the possibility of the transition to the CsCl structure at a pressure as low as 20 kb. Such a low pressure transition would unacceptably complicate the use of NaCl as a continuous pressure standard. Others[6,7,8,9] have found no evidence for a transition as low in pressure as this. From the work of Jamieson[9,10] on the solution salts, $Na_xK_{1-x}Cl$, one can conclude that the B1 to B2 transition must be considerably above 130 kb in the pure end number,