

ship is derived between the two-phonon nuclear relaxation time and the direct, electronic relaxation time for the levels of the Kramer's doublet. Available data on the electronic relaxation are in satisfactory agreement with

predictions.

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MONDAY AFTERNOON, 29 MARCH 1971

AVIATION ROOM—PICK-CARTER AT 2:00 P.M.

(L. SLIFKIN presiding)

Diffusion I

BJ 1 Diffusion Measurements at High Pressures.\*  
D.L. DECKER and H.B. VANFLEET, Brigham Young Univ. -- The rate of diffusion of Au, Ag, and Cu into lead as well as Li into Ge has been measured between 0 and 50 kbar pressure and from 200 to 600°C. It has been proposed that two mechanisms are involved in the diffusion of these couples,<sup>1,2</sup> but the results can also be analyzed by assuming a single mechanism with an activation volume which is pressure and temperature dependent. One most interesting feature of this analysis is that it predicts an increase in the specific heat of the crystal, with the solute at the activated site, of  $1/2R$  per mole of solute for all four diffusion couples. The results of  $D_0$ ,  $\Delta H$ ,  $\Delta V$ ,  $\partial\Delta V/\partial T$ ,  $\partial\Delta V/\partial P$ , and  $\Delta C_p$  will be reported for all these materials.

\*Work supported by NSF.

<sup>1</sup>H.R. Curtin, D.L. Decker, and H.B. Vanfleet, Phys. Rev. 139, A1552 (1965).

<sup>2</sup>G.V. Kildson, Phil. Mag. 13, 247 (1966).

BJ 4 Hydrogen Diffusion in Yttrium Trihydride.\*  
H. T. WEAVER, Sandia Laboratories -- Nuclear magnetic resonance measurements of spin-lattice relaxation times ( $T_1$ ) and line profiles have been carried out as a function of temperature for  $^1\text{H}$  contained in  $\text{YH}_x$  ( $2.6 \leq x < 3.0$ ). In the concentration range  $x > 2.8$ , for which a single hexagonal hydride phase exists, the resonance spectrum displays narrowing at temperatures of 10 and 70°C indicative of separate diffusion processes. In addition, these samples displayed two relaxation rates at temperatures near the diffusion induced minimum for  $T_1$ . The relative number of nuclei responsible for the higher temperature phenomena increases with concentration, but the presence of superimposed spectra prevented an accurate activation energy determination for this process. However, for samples with  $x$  values of 2.6 and 2.83, from which essentially a single spectrum resulted, an activation energy of  $0.37 \pm .05$  eV could be determined by both line width and relaxation time methods. Possible origins for the double diffusion mechanism are discussed in terms of simple models.

\* Work supported by the U. S. Atomic Energy Commission.

BJ 2 Effect of Hydrostatic Pressure on the Self-Diffusion Rates in Cadmium.\* B.J. BUESCHER and H.M. GILDER, Rensselaer Polytech. Inst. -- The pressure effect on the self-diffusion rates in single crystals of cadmium parallel and perpendicular to the hexagonal axis has been measured using the radio-tracer sectioning technique at 300°C over the pressure range 0 - 8 kb. Activation volumes of  $\Delta V_c = 7.56 \pm .09$  cm<sup>3</sup>/mole and  $\Delta V_b = 7.49 \pm .09$  cm<sup>3</sup>/mole were determined at this temperature, and within the experimental error, the activation volumes were found to have no detectable anisotropy. Investigations of the pressure effect on the cadmium self-diffusion rates at 250°C and 275°C will also be reported.

\*Supported by the U.S. Atomic Energy Commission through Contract AT(30-1)-3820.

BJ 5 Diffusion of Zinc in AgCl.\* A.P. BATRA and L.M. SLIFKIN, Univ. of North Carolina at Chapel Hill. -- The Arrhenius plot for the diffusion of Zn in AgCl is found to consist of two segments with a break at 352°C. Above the breakpoint, the activation energy and the pre-exponential factor are, respectively, 1.04eV and 7.05 cm<sup>2</sup>/sec, whereas the corresponding values below are 0.78eV and 0.055 cm<sup>2</sup>/sec. These data are not in conflict with the previously proposed substitutional-interstitial model, but do not unambiguously corroborate it. At low temperatures (~215°C), the tracer distribution is gaussian only if an exceedingly small amount of the carrier-free tracer is used. This implies a very extensive association between the zinc and the cation vacancy, and suggests an appreciable attraction between the zinc ion-vacancy complex and another zinc ion or complex.

\*Work Supported by the U.S. Atomic Energy Commission, Contract AT-(40-1)-2036.

BJ 3 The Effect of Pressure on Sodium Self-Diffusion.\* JOHN N. MUNDY, Argonne Natl. Lab. -- The diffusion of  $^{22}\text{Na}$  in sodium has been measured over the temperature range -78.5 to 97°C and the data do not fit a linear Arrhenius relation. The data indicate that at least two and possibly three jump mechanisms could be responsible for the diffusion behavior. The diffusion of  $^{22}\text{Na}$  in sodium has been measured as a function of pressure over the range from ambient pressure to 9500 kg cm<sup>-2</sup> at 14.8 and 91.3°C. The log D versus pressure results also show curvature and are in substantial agreement with the ambient pressure data. Isotope-effect measurements have been made over the temperature range -25.0 to 97°C at ambient pressure. The isotope effect decreases as the temperature increases over the entire temperature range, with a more rapid decrease above 70°C. It is not possible to determine unambiguously the mechanisms of diffusion in sodium. The evidence appears to favor a vacancy mechanism at low temperatures with an increasing contribution from divacancies as the melting temperature is approached.

\*Work performed under the auspices of the U. S. Atomic Energy Commission.

BJ 6 Cation Diffusion and Conductivity in Solid Electrolytes. H. SATO, Ford Motor Co., and R. KIKUCHI, Hughes Research Laboratories -- The path probability method is used to derive both the tracer diffusion and the ionic conductivity of some typical solid electrolytes. The problem is characterized by a cation migration by the vacancy mechanism in a "cation disordered phase", a system in which the number of available vacant sites is at least of the same order of magnitude as the number of diffusing cations. When the derived tracer diffusion coefficient is interpreted in terms of conventional random walk approach, the jump frequency of cations is found to include two extra factors which take into account the effect of surroundings of the migrating ion and characterize the cooperative mode of cation motion. These two factors as well as the correlation factor  $f$  depend strongly on composition of cations and on temperature. The Nernst-Einstein relation which re-