to within 0.5 percent in nine cases, and to within 1.0 percent in all cases. While the data are insufficient to show definitely that the method of calculating densities developed in this paper is applicable to these other types of oils, there seems to be good indication that it is.

Two thermodynamic quantities of interest, the isothermal compressibility and the thermal expansivity, can be calculated from the data of this paper. The compressibility can be obtained by differentiation of the density equation at the temperature corresponding to the constants a and b, and, if computed at two pressures, shows a normal decrease with increase of pressure. On the other hand, if the compressibility is calculated at two temperatures, it will be found to increase with temperature. The thermal expansivity can be calculated by applying the density equation at two temperatures at constant pressure. If computations are made at two pressures it will be found that the expansivity decreases also with increase of pressure. In regard to these derived quantities it should be noted that they cannot be calculated to an accuracy claimed for the basic density data. However, this lack of accuracy becomes important only at the lowest pressures where possible inaccuracy in measuring pressure by means of the manganin coil is recognized.

An X-Ray Method of Determining Rates of Diffusion in the Solid State

Jesse DuMond and J. Paul Youtz

California Institute of Technology, Pasadena, California

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Gold and copper were simultaneously deposited in vacuum by vaporization on a plate of glass, the copper being deposited at a uniform rate while the gold was deposited in one hundred stratified layers in the copper by alternately raising and lowering the temperature of the molybdenum vaporizing trough containing the boiling gold. The translucent deposit so formed had a total thickness of about 10,000A and hence an average interplanar distance of 100A. In an especially constructed x-ray spectrograph selective diffraction of Mo K radiation from the stratified films was observed corresponding to the artificially imposed periodicity of the stratification and the intensity of this diffracted image relative to the direct beam was found to fall off with time so as to indicate a "half-life" for the stratified structure of about two days. This suggests a general method for the study of average rates of diffusion and the determination of diffusion coefficients of solids in solids by utilizing the decay of such stratified films. Simple theoretical considerations indicate that such an artificial stratification should, through the action of diffusion alone, rapidly and automatically lose the higher Fourier harmonics of its periodic density distribution function and retain the fundamental in such a way as to render the determination of the diffusion coefficient quite accurate. The observed behavior of the diffracted maxima seem to support these expectations as does also the absence of any intensity in higher orders than the first. This purification by diffusion probably takes place principally during the depositing process itself while the temperatures are still quite high. Formulae are derived relating the observed rate of decay of the diffracted intensity, the artificial "grating constant" of the strata, and the diffusion coefficient. The method seems especially promising for substances and temperatures where diffusion is so slow as to be otherwise quite unobservable because the diffusion time varies as the square of the distance over which atoms must migrate and in this method these distances are many orders of magnitude smaller than in any other.

I. Introduction

When the experiments here described were started[1] our purpose in trying by controlled evaporation in vacuum to produce artificially stratified layers of two different substances (gold and copper) was to develop, if possible, a technique of measuring the absolute wave-length of x-rays by a type of diffraction more nearly resembling Bragg reflection than is the case in the

[1] J. DuMond and J. P. Youtz, Phys. Rev. **48**, 703 (1935); also for unsuccessful attempts to produce artificial x-ray reflectors see H. Koeppe, Dissertation Gieszen 1923, and Kiebner, Ann. d. Physik **5**, 261 (1930).