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## Melting Properties of He<sup>3</sup> and He<sup>4</sup> up to 3500 kg/cm<sup>2</sup>\*

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For He<sup>3</sup> and He<sup>4</sup> the volume change on melting,  $\Delta V_m$ , the molar volume of fluid,  $V_f$ , and the fluid thermal expansion coefficient,  $\alpha_f = (1/V_f)(\partial V_f/\partial T)_P$ , were measured along the melting curve from 1.3 to 31°K at pressures up to 3500 kg/cm<sup>2</sup>. These are the first such measurements to be reported for He<sup>3</sup>; for He<sup>4</sup> they are the first measurements, consistent with melting curve determinations, which cover this pressure range accurately. Detailed studies of all the melting parameters were made at pressures below 250 kg/cm<sup>2</sup> for both isotopes. Two solid forms of He<sup>3</sup> were found with a transition line which intersects the melting curve at 3.15°K and 141 kg/cm<sup>2</sup>. For He<sup>4</sup> an indirect determination was made of the intersection of the lambda line with the melting curve.

### I. INTRODUCTION

Although the melting curves of He<sup>3</sup> and He<sup>4</sup> have been traced in considerable detail from a few tenths of a degree absolute up to 30 and 50°K, respectively, (1-12) there exist no measurements of the corresponding volume change on melting,  $\Delta V_m$ , for He<sup>3</sup> and no direct measurements for He<sup>4</sup> above 4°K. Such data in combination with slopes of the melting curves are useful in deriving the various thermodynamic quantities of melting. For He<sup>4</sup>,  $\Delta V_m$  measurements have been made by Swenson (6, 7, 13) in the region 1.2 to 4.0°K. In addition there are indirect measurements by Keesom and Keesom (9) in the region 2.2 to 4.0°K, and by Dugdale and Simon (3) in the region 4 to 26°K. The most precise of these measurements occur below 4°K where the quoted (6, 7) error is 3 percent. For He<sup>3</sup> and He<sup>4</sup>,  $\Delta V_m$  data consistent with the melting curve determinations in accuracy and extent (1) are especially desirable.

Reported here are final determinations of the volume change on melting of He<sup>3</sup> and He<sup>4</sup> up to 3500 kg/cm<sup>2</sup>. It should be noted that some preliminary data have already been presented (14). This study is part of a continuing program to measure the melting parameters for all the low boiling gases; in the past measurements for N<sub>2</sub> were reported (15).

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