

Melting Properties of He³ and He⁴ up to 3500 kg/cm²*

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For He³ and He⁴ the volume change on melting, ΔV_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/cm². These are the first such measurements to be reported for He³; for He⁴ 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/cm² for both isotopes. Two solid forms of He³ were found with a transition line which intersects the melting curve at 3.15°K and 141 kg/cm². For He⁴ an indirect determination was made of the intersection of the lambda line with the melting curve.

I. INTRODUCTION

Although the melting curves of He³ and He⁴ 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, ΔV_m , for He³ and no direct measurements for He⁴ above 4°K. Such data in combination with slopes of the melting curves are useful in deriving the various thermodynamic quantities of melting. For He⁴, ΔV_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 He³ and He⁴, ΔV_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 He³ and He⁴ up to 3500 kg/cm². 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 N₂ were reported (15).

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