*J. Phys. Chem Solids* Pergamon Press 1967. Vol. 28, pp. 439–447. Printed in Great Britain.

# ELASTIC CONSTANTS AND CALCULATED LATTICE VIBRATION FREQUENCIES OF $Mg_2Sn$*

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(*Received* 8 *August* 1966)

**Abstract**—The longitudinal and shear sound velocities of $Mg_2Sn$ in the [100], [110] and [111] directions have been measured between 80 and 300°K by a resonance technique. The elastic constants were computed from these velocities. Lattice vibration frequencies have been calculated for two point ion models and a shell model. Best agreement with the experimental specific heat data was obtained for the shell model, which reproduced quite accurately the sharp minimum in the Debye temperature near 20°K.

## INTRODUCTION

$Mg_2Sn$ IS A II–IV compound semiconductor with the fluorite structure and is a member of the family of compounds $Mg_2X$, where $X$ can be Si, Ge, Sn, or Pb. The elastic constants and calculated lattice vibration frequencies have been reported for $Mg_2Si$ by WHITTEN *et al.*(1) and for $Mg_2Ge$ by CHUNG *et al.*(2) The present investigation was undertaken to extend our knowledge of the elastic properties of the $Mg_2X$ family to include $Mg_2Sn$.

The reststrahl frequency and high and low frequency dielectric constants of $Mg_2Sn$ have been measured by KAHAN *et al.*(3) Just as in the cases of $Mg_2Si$(1) and $Mg_2Ge$,(2) it seemed feasible to calculate the lattice vibration frequencies from these optical constants and the elastic constants which we could measure. In addition to the two point ion models described by CHUNG *et al.*,(2) a new model which takes into account the polarizability of the Sn ions can be used. The calculated specific heat of the three models can then be compared to the experimental data of JELINEK *et al.*(4)

The phonon dispersion curves are important for an interpretation of the semiconducting properties of these compounds.(5–7) Piezoresistance measurements have shown that the energy minima lie along the ⟨100⟩ axes in $Mg_2Si$(8) and in $Mg_2Sn$.(9) Therefore, a knowledge of the phonon frequencies in the ⟨100⟩ directions is particularly important since such phonons are involved in indirect transitions between the valence band and the conduction band.

## EXPERIMENTAL SOUND VELOCITIES AND ELASTIC CONSTANTS

The velocity of sound in $Mg_2Sn$ was measured by a resonance technique. Two 10 MHz quartz transducers were bonded to opposite parallel faces on each sample. One transducer was driven by the output from an Arenberg ultrasonic oscillator, Model PG-650C, operating in the continuous wave mode. The output of the other transducer was amplified and displayed on a scope. Frequencies were measured with a Bolton Labs BC-221-AL frequency meter. The sample holder is shown in Fig. 1. Two different materials were used to bond the transducers to the sample: below 250°K, vacuum grease was used; and above 250°K, beeswax was used.

Single crystal ingots were grown by a Bridgman method. Three samples were prepared with orientations [100], [110], and [111]. The sample lengths were 0·520, 0·375 and 0·943 cm, respectively.

* Work was performed in the Ames Laboratory of the U.S. Atomic Energy Commission. Contribution No. 1943.

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