MASTER

COO-4056-1

THE DEVELOPMENT OF FERROMAGNETIC SPINELS
FOR OPTICAL ISOLATION AT 10.6 μm

Progress Report,
for Period August 1, 1976-October 31, 1976

Kenneth Teegarden

University of Rochester
Rochester, New York 14627

NOTICE
This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Energy Research and Development Administration, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

November 1976

Prepared For

THE U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
UNDER CONTRACT NO. EY-76-02-4056.*000

~~427 attached~~
DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED
pg

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Energy Research and Development Administration, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product or process disclosed or represents that its use would not infringe privately owned rights.

ABSTRACT

During this quarter, emphasis was placed on the growth of small single crystals of CdCr_2S_4 . The size and morphology of the crystals was studied as a function of growth parameters. Facilities for increasing the chemical purity of the crystals were constructed.

THE DEVELOPMENT OF FERROMAGNETIC SPINELS FOR OPTICAL ISOLATION AT 10.6 μm

I. Progress to Date

In compliance with the scope of work under this contract, single crystals of CdCr_2S_4 were grown using a modified version of the technique described by Von Neida and Shick⁽¹⁾. One significant difference between the method employed in this investigation and that reported in the literature was the use of Cd foil instead of Pt as a getter for excess sulfur. This modification is important because it significantly reduces the cost of producing CdCr_2S_4 .

The relationship between crystal size and quality and the many variable parameters controlling crystal growth was extensively investigated. The results are given in Table I. Certain conditions appear to favor larger crystals or more "perfect" crystals as characterized by optical micrographs.

Facilities to improve the purity of single crystal CdCr_2S_4 were set up during this period. A dry-box in which the various operations involved in the preparation of materials prior to crystal growth can be carried out in an inert atmosphere was designed and constructed. This chamber will also be used to protect materials during the preliminary operations leading to hot forging of blanks of CdCr_2S_4 .

The principal investigator was on sick leave for the months of September and October; otherwise, he devoted 30% of his time to the work.

II. Objectives for the Next Quarter

A. Single crystals of CdCr_2S_4 grown to date will be polished and the intrinsic absorption coefficient α measured at 10.6 μm to determine

(1) R. Von Neida and L.K. Shick, J. Appl. Phys. 40 1013 (1969).

the relationship of this parameter to the conditions of crystal growth. This measurement will be made both at room temperature and 77°K (liquid nitrogen temperature). It is possible that α may be smaller at lower temperatures, where isolators fabricated from this material will normally operate.

B. Guided by the results of the above measurement, new crystals of CdCr_2S_4 will be grown so as to minimize α at 10.6 μm . The optical absorption of these crystals will be characterized at room temperature and 77°K as before.

C. In parallel with the above, hot forging of blanks from single crystal material will be initiated. The effect of hot forging parameters on α will be the prime focus of this effort.

D. An investigation of the feasibility of preparing single crystal CoCr_2S_4 by employing the techniques used for CdCr_2S_4 will be made.

The principal investigator intends to spend 30% of his time on this contract during the next quarter.

TABLE I

The Growth of CdCr_2S_4 Crystals

Trial	Conditions	Observations
1	Method used by T. Cheng & Shick & Von Neida	Small (< .3 mm/side) crystals observed, quartz tube cracked
2	Repeat #1.	Explosion
3	Trial #1 with reduced quantities T=850°C for 3 days. Mole ratio 2.21/1/.45 (CdS, CoCl_3 , Cd foil)	Large (1.1 mm/side max.) crystals produced
4	Change temperature to 800°C	Crystals as large as in #3 produced
5	Tilt furnace at 20° angle 50° Temp. gradient across quartz tube	Largest (1.5 mm/side) "Imperfect" crystal
6	Platinum getter instead of Cd	Tiny (< .3mm/side) but "Perfect" crystals
7	8 hour linear cool down of furnace (normally 4 hour exponential)	Large (1mm/side) but "Perfect" crystals
8	Change mole ratio to 1.5/1/.45 keeping amount of CrCl_3 consistent	Smaller crystals than trial 3. Also smaller yield
9	Mole ratio to 2.5/1/.45	Highest yield of large (mm) crystals
10	Combination temp. gradient and inclination; T=800°C Cd foil getter, 8 hour cool down, 2.5/1/.45 mole ratio	Nothing special, yield and sizes near that of trial 3.