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THE DEVELOPMENT OF FERROMAGNETIC SPINELS FOR OPTICAL ISOLATION AT 10.6 μm

Progress Report
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NOTICE

ABSTRACT

During this quarter, measurements of the optical absorption coefficient, α , of crystals of $CdCr_2S_4$ were measured at 10.6 μm and room temperature, and correlated with growth parameters established during the last quarter. A minimum absorption coefficient of 15.6 cm^{-1} was obtained. Procedures for hot forging crystals of $CdCr_2S_4$ were established in preparation for a study of the effect of forging on the optical absorption. Sincle crystals of $CoCr_2S_4$ were also grown using a technique closely related to that previously employed for $CdCr_2S_4$.

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I. Progress to Date

Single crystals of $CdCr_2S_4$, described in Table I of the first progress report (COO-EY-76-S-02-4056*000-1), were polished and the optical absorption coefficient, α, measured at 10.6 μm and room temperature using a CO_2 laser, with the results shown in Table I. The best value of α obtained was 15 cm^{-1}. The dependence of α on method of preparation indicated in the table, provides well-defined guidelines as to the conditions needed to minimize α.

Although the best values of α obtained to date are a factor of 100 too high relative to the objectives of this project, they are low enough to enable us to proceed toward another of our most important objectives; namely, a study of the effect of hot pressing on α. Even with an α of 15 cm^{-1}, a hot pressed disk 1 mm. thick will transmit 22% of incident radiation at 10.6 μm, neglecting reflection losses. This is more than enough to permit measurements of α in the hot pressed samples, and a detailed study of changes in α produced by hot pressing .

In compliance with an additional objective of this project, single crystals of $CoCr_2S_4$ have been grown using the technique employed for $CdCr_2S_4$, except for the substitution of CoS for CdS. This is an important result because it indicates that we can include this material (which has a higher operating temperature) in our studies with relatively minor changes in procedure.

Preliminary experiments on hot pressing or forging of blanks from crystalline $CdCr_2S_4$ have taken place. These have been directed towards establishing the parameters needed to obtain samples with good density and mechanical properties, before attempting to fabricate material with the lowest α. All indications are that we can achieve the conditions needed for good optical quality with present apparatus.

After considerable investigation into alternative equipment, a pulsed CO_2 laser for conducting damage tests has been ordered. The laser chosen is a TEA laser providing .7 joules in a 40 ns. pulse, Too mode, manufactured by Tachesto, Inc. It is expected early in the next quarter.

II. Objectives for the Next Quarter

A. During the next quarter absorption measurements will be made on crystals of $CdCr_2S_4$ at 77^0 K, to establish the value of α at this temperature.

B. Growth of single crystals of both $CdCr_2S_4$ and $CoCr_2S_4$ will continue, to minimize the value of α in these materials.

C. Hot forging of both $CdCr_2S_4$ and $CoCr_2S_4$ will continue with emphasis on the optical properties of the forged samples. A study of the change in α introduced by forging, using crystals described in Table I will be carried out.

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

TABLE I

$CdCr_2S_4$ Room Temperature Absorption Coefficient Results

Trial	Crystal Growing Method	Range of Polished Crystal Thickness (μm)	Range of absorption Coefficients (cm^{-1})
3	Schick & VonNeida method temp.=850°C, mole ratio 2.2/1/.788 (CdS, $CrCl_3$, Cd) exponential cool down	209 - 536	45.0 - 102
4	Trial 3 with temp.=800°C	285	15.6
5	Trial 3 with furnace tilted at 20° angle, 50°C gradient across tube	382 - 534	41 - 72
7	Trial 3 with linear cooling rate	380 - 465	50 - 76
8	Trial 3 with mole ratio 1.5/1.0/.788 (CdS,$CrCl_3$Cd) keeping amount of $CrCl_3$ constant	270 - 272	33 - 75.0
9	Trial 8 with mole ratio 2.5/1.0/.788 (CdS, $CrCl_3$, Cd)	412 - 455	19.8 - 43
10	Shick & Von Neida method only temp.=800°C, mole ratio 2.5/1/.788, linear cooldown, 20° angle tilt, 50°C gradient	283 - 301	63 - 101