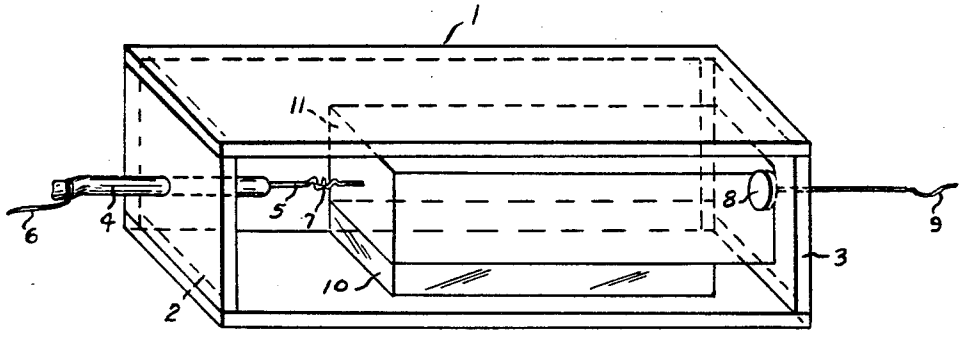
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METHOD OF MAKING DIVALENT RARE EARTH LASER CRYSTALS IN AN ELECTRIC FIELD

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INVENTOR
FRANCIS K. FONG

BY Harry A. Herbert Jr. and Orlando 2. McCoy
ATTORNEYS

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METHOD OF MAKING DIVALENT RARE EARTH LASER CRYSTALS IN AN ELECTRIC FIELD

Francis K. Fong, Thousand Oaks, Calif., assignor to the United States of America as represented by the Secretary of the Air Force

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3 Claims. (Cl. 204—164)

This invention relates to the production of stable divalent rare earth lasers using electrolytic means applied to a reduction cell containing a crystal to be reduced.

The object of the present invention is the provision of a new and improved crystal reducing cell and a simple, convenient, and a general technique for the in situ reduction of trivalent rare earth ions in a crystalline material capable of light amplification.

The rare earth metals have atomic numbers beginning with 58 for cerium, or, in some classifications, with 57 for lanthanum, and extending through 71 for lutetium.

The matter of light energy amplification theory, experimentation and use, illustratively is published in the Journal of Chemical Physics, vol. 41, p. 245, in 1964; in Applied Physics Letters, vol. 4, No. 10, p. 172, May 15, 1964; by Schawlow in Scientific American for July 1963, p. 34 et seq.; by Vogel in Electronics dated in 1961 for Oct. 27, Nov. 3, 10, 24 and Dec. 22; by Hayes and Twidell in the Journal of Chemical Physics, vol. 35, p. 1521, in 1961; and Schawlow and Townes in the Physical Review, vol. 112, p. 1940, in 1958, and vol. 120, p. 1154, in 1960.

The crystals containing divalent rare earth materials that are prepared by the use of the cell that is disclosed herein are stable under normally operating conditions of light and heat.

The cell is illustrated diagrammatically in the single figure of the accompanying drawing.

The cell in the drawing comprises a hollow container 1 of electrically nonconducting material such as a desired ceramic, and terminating in end members 2 and 3. The interior of the housing 1 is made accessible from the outside by suitable means such as by having a removable cover, a door, or the like.

One of the end members, such as the end member 2 of the container 1, accommodates an axially adjustable cathode support 4 that has one end of a tungsten wire 5 welded to its end inside the container 1 and an electrical connection with a wire 6 at its end remote from the container 1. A coil 7 that is intermediate the ends of the cathode tungsten wire 5 imparts resilience axially thereof. The other end of the container 1 has a gold sheet contact member 8 supported thereby. The gold contact member 8 is maintained at a desired electrical potential by a wire 9.

Suitable crystal support means 10 is positioned inside of the container 1 for the positioning of a crystal 11 thereon in electrical connection between the tungsten point of the wire 5 and the gold contact member 8. The gold contact member 8 may be made of gold sheet, platinum, silver, or the like.

The crystal 11 is of a type used in laser devices and illustratively is one of the compositions: $CaF_2:Dy^{+3}$, $SrCl_2:Ho^{+3}$, or $BaBr_2:Tm^{+3}$ that is adapted to be reduced by electrolytic means.

In the operation of the above described cell the cathode is the contact point of the tungsten wire 5 and the anode is the gold sheet contact 8.

The container 1 illustratively is a furnace wherein the reduction of the dopant in the crystal is carried out at temperatures above 300° C. and at voltages up to about 300 volts, although the furnace conditions may be varied considerably with equally satisfactory results.

The steps of the process that are contemplated hereby are the disposition of the crystal 11 within the furnace and setting the furnace controls at 300° C. When the crystal temperature is above about 300° C. the reduction potential of up to about 300 volts is impressed across the crystal 11 for the reduction of all of the rare earth ions to their divalent state, thus eliminating the danger of over-reducing the rare earth ions to their metallic state. In general, the higher the furnace temperature is, the lower the voltage needs to be.

The crystals 11 so reduced are in a stable state of reduction from alterations by normal ambient light and heat.

The process here disclosed applies to all of the described hosts.

The lifetimes of the divalent emission of the reduced crystals is considerably longer than the lifetimes of photo-reduced corresponding samples.

The method that is described herein is accomplished relatively easily and with a minimum of complications.

It is to be understood that the process steps that are described herein are illustrative and that limited modifications may be made therein without departing from the scope of the present invention.

I claim:

1. The process of producing a stable divalent rare earth laser crystal from a $CaF_2:Dy^{+3}$ crystal comprising the steps of positioning the crystal between a tungsten point cathode and a gold sheet anode, increasing the temperature of the crystal above about 300° C., impressing a potential of about 300 volts between the cathode and the anode and through the crystal, and maintaining the crystal above about 300° C. and up to about 300 volts to the production of the stable divalent rare earth laser crystal.

2. The process of producing a stable divalent rare earth laser crystal from a $SrCl_2:Ho^{+3}$ crystal comprising the steps of positioning the crystal between a tungsten point cathode and a gold sheet anode, increasing the temperature of the crystal to above about 300° C., impressing a potential up to about 300 volts between the cathode and the anode and through the crystal, and maintaining the crystal above about 300° C. and up to 300 volts to the production of the stable divalent rare earth laser crystal.

3. The process of producing a stable divalent rare earth laser crystal from a $BaBr_2:Tm^{+3}$ crystal comprising the steps of positioning the crystal between a tungsten point cathode and a gold sheet anode, increasing the temperature of the crystal to above about 300° C., impressing a potential up to about 300 volts between the cathode and the anode and through the crystal, and maintaining the crystal at above about 300° C. and up to about 300 volts to the production of the stable divalent rare earth laser crystal.

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ROBERT K. MIHALEK, *Primary Examiner.*