Clemson University Research Foundation

Low Temperature Hydrothermal Growth of Quality Lanthanide Vanadate/Oxide Crystals (03-003, 07-001)

Grows Suitable Crystals Doped with Activator Ions for Various Laser Applications

Market Overview

This crystal growth approach utilizes a hydrothermal process to produce single crystals of sufficient size for use in a variety of optical laser applications. There is a consistent, increasing demand for higher performance materials in optical applications. The desired materials include high quality single crystals that are capable of being cut, shaped, and polished appropriately for use in non-linear optical lasers. Traditionally, melt pulling practices are used for growing crystals; however these practices do not produce quality crystals due to oxygen deficiency during the process. Clemson University researchers have developed a low temperature hydrothermal growth technique in which the compounds are produced in water that is heated above the boiling point under pressure. In particular, this approach focuses on producing lanthanide vanadate and lanthanide oxide crystals having the formula LnVO4 and Ln2O3, respectively, in which Ln is selected from a variety of metals and can subsequently be doped with another metal acting as an activator ion if desired.

Application

Optics, Solid-state lasers; Crystal manufacturing

Stage of Development

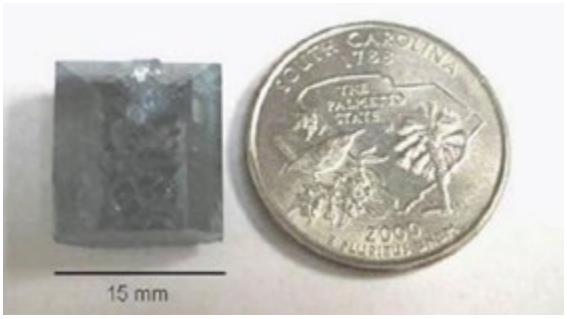
Proof of Concept

Advantages

- Employs hydrothermal growth approach, creating commercially viable conditions for mass production of large, quality crystals
- Requires low temperatures for growth, producing crystals with less thermal strain, fewer defects, and greater homogeneity than conventional growth methods

Technical Summary

Utilizing hydrothermal growth, this approach can be used to grow high quality single crystals of $LnVO_4$, $Ln'LnVO_4$, Ln_2O_3, and $Ln'Ln_2O_3$. Ln can be a variety of metals, such as, La, Nd, Y and others. The doping activator ion, Ln', can also be a variety of similar metals and other metal ions possessing a trivalent charge including Cr3+ and Ti3+. In particular there, was a focus on generating YVO_4 and doped YVO_4 crystals. The crystal growth process is a low temperature hydrothermal process in which the crystals are being grown in an aqueous solution at a temperature generally within the range of 350oC-600° C under pressure. Ultimately, Clemson University researchers successfully created a procedure that allows economically efficient mass production of large, high quality single crystals that are suitable for various laser applications.



Hydrothermally grown Nd:YVO_4 crystal (US quarter for scale)

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About the Inventor

Dr. Joseph Kolis is a Professor of Inorganic Chemistry at Clemson University, He earned his Ph.D. at Northwest University working in organometallic chemistry and conducted postdoctoral research at McMaster University. Dr. Kolis is a founding member of the Center for Optical Materials Science and Engineering Technologies (COMSET) at Clemson University where his group studies the synthesis and chemistry of novel inorganic compounds that demonstrate unusual structures and properties. He is the recipient of numerous awards, including the National Science Foundation Award for Special Creativity and the Alfred P. Sloan Fellowship and holds over seven patents.

For More Information

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Application Type	Country	Serial No.	Patent No.	CURF Reference No.	Inventor
Utility	United States	11/029,291 12/002,551	7,211,234 7,563,320	03-003 07-001	Joseph Kolis, Steve Syracuse, Colin McMillen