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# Internal Gradient Doping of Host Crystals for Improved Quality of Solid State Lasers (2011-063)

*Hydrothermal Approach Varies the Dopant Ion Concentration within Laser Crystals to Improve Solid State Laser Quality and Sophistication*

## Market Overview

This hydrothermal approach provides variation in the concentration of selected dopants within the host single crystal lattice, resulting in improved power and beam quality of solid state lasers. The global market for solid state lasers is projected to steadily increase, reaching $850 million by 2020. This steady growth is primarily due to the demand for lasers with operational thresholds that can be reached at relatively low intensities of laser pumping. One way to achieve low intensities of laser pumping includes varying the laser ion dopant concentration. Existing practices of doing this, however, are cumbersome and infeasible. Clemson University researchers have developed a practical way to vary the dopant ion concentration within the laser crystals that ultimately improves the quality of high powered lasers by eliminating thermal defects. The hydrothermal approach will enable growth of laser crystals with greatly increased sophistication and optical efficiency, dramatically increasing the performance of solid state lasers by achieving appropriate gradient doping.

## Application

Optic industry; High power lasers

## Stage of Development

Validated Prototype

## Advantages

- Eliminates thermal effects that degrade the quality of the laser output beam, improving power and beam quality of solid state lasers
- Allows for relatively complex doping profiles to be scaled to commercial quantities, providing a simple way to mass produce needed materials for laser applications
- Enables dopant ion concentration in each layer can be increased or decreased as desired, resulting in dopant profiles that will increase the performance of elaborate laser designs

## Technical Summary

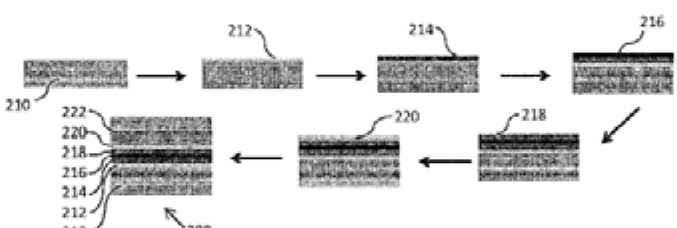

FIG. 5

Clemson University researchers have developed a hydrothermal method to prepare single crystal oxide hosts doped with lasing ions. The dopant ion concentration in each layer can be increased or decreased as desired, producing a uniform single crystal with a controlled variation of dopant ion. A typical host crystal, such as YAG, can have a section of the crystal which is doped with an increasing or decreasing concentration of lasing ions such as $Yb^{3+}$ or $Nd^{3+}$. The gradient can range smoothly and gradually over a wide gradient from 0% to a large value such as 50% and then back to 0%. The gradient profile can occur anywhere inside the host, from the surface to the center of the host crystal. The overall resulting product is one high quality single crystal. This approach is very useful for laser applications that demand high power or exceptionally efficient performance because it eliminates many of the thermal effects that degrade the quality of the laser output beam

For More Information Contact: Andy Bluvas | bluvasa@clemson.edu | (864) 656-5157 | CURF Reference No. 2011-063

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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

To learn more about this technology, please contact:

**Andy Bluvas**
Technology Commercialization Officer
bluvasa@clemson.edu
(864) 656-5157

| Application Type | Country | Serial No. | Patent No. | CURF Reference No. | Inventor |
|---|---|---|---|---|---|
| Non-provisional | United States | 13/923,942 | NA | 2011-063 | Joseph Kolis; Colin McMillen; |