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Hydrothermal Growth of Thin Film, Co-Doped Crystals with Optimized Properties for Mass Production (2010-051, 09-056, 09-055)

An Approach for Growing Crystals with Optimized Mass Production Properties for Micro and Solid State Laser Applications

Market Overview

This alternative approach for growing thin film and co-doped crystals uses hydrothermal techniques that result in optimized crystal qualities, ideal for solid state laser applications. Solid state lasers are used in a wide variety of applications, including the defense, communication, and medical fields. This broad spectrum of uses and the consumer demand for lasers in low-power applications have contributed to a growth in the market, leading to a prediction of a market value of $850 million by 2020. Clemson University researchers created a crystal growth process ideal for solid-state laser applications in which a layer with controlled thickness of doped or undoped host material can be grown on a substrate which is also doped or undoped but with a slightly different composition. This allows for improved controlled thickness and composition of an activator region as well as laser pulses with high peak powers.

Application

Optics; Solid state lasers

Stage of Development

Validated Prototype

Advantages

- Creates multiple regions of functionality in the crystal host, providing better thermal management and ability to control the thin film growth rate
- Allows co-doping of both ions in the same lattice, producing fundamentally unique crystals that are appropriate for mass production of lasers
- Process can be readily scaled to large numbers of samples simultaneously, eliminating time as a hindering factor and allowing mass production of required laser materials

Technical Summary

This approach relates to the use of hydrothermal epitaxial growth for the mass production of crystals – specifically with two doping metal ions in the same region of the single crystal, namely a lasing ion and a Q-switch, so that each layer can perform an appropriate function related to lasing. The multifunctional layers combine to form a crystal suitable for use in a solid state microlaser cavity. In particular, Clemson University researchers focused on the hydrothermal growth of crystals on an yttrium aluminum garnet (YAG) or vanadate host. These substrate hosts typically contain one region doped with a suitable active lasing ion and another region that is undoped that can act as an endcap or substrate for contact to a heat sink. This improves thermal management due to inhibiting thermal lensing at high powers. Overall, the use of hydrothermal epitaxial methods to grow layers with controlled thickness and dopant concentration for use in lasers, thin film lasers, end caps, Q-switches, microlasers, and optical isolators is a substantial improvement in the solid state laser industry. The proposed approaches provide a number of advantages and improvements over a liquid phase epitaxy or optical bonding methods that are currently used, enabling a variety of inexpensive and higher performing lasing devices to be developed..

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	12/832,119 12/832,115 12/832,108	9,014,228	2010-051 09-056 09-055	Joseph Kolis; Colin McMillen; Matthew Mann; John Ballato