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A Novel Composite Ceramic Laser Material Embedded With Single Crystal Rare-Earth Compound Nanorods

Rare-Earth (RE) related laser materials typically suffer from several key drawbacks. Materials are made by doping ceramic powders with rare earth elements, but this approach has many associated drawbacks. Low doping density limits the optical gain to a relatively low level, while doping levels which are too high cause nonhomogeneous dopant distributions. Both of these issues cause nonlinear saturation of optical gain, resulting in overall performance defects for the laser. Ceramic materials also have problematic interaction of dopants with defects and grain boundaries, which causes serious material degradation along with further reduction of optical gain. Ion clustering increases the nonlinear saturation effects which can degrade the laser's light emission. Traditional methods are also expensive and difficult to make in large enough volumes for high power applications.

Researchers at Arizona State University have invented a novel class of ceramic laser materials embedded with high quality single crystal rare-earth compounds (SinCRECS) in nano-rod form. These compounds contain light emitting RE ions as integral parts of the crystal constituents, decreasing the randomness of dopant distribution. This new approach makes control of RE-ion density easier and more precise, since exact density is controlled by the physical material used for each specific laser application. RE-atoms are also tightly bound to a single crystal structure, minimizing diffusion to grain boundaries and improving laser performance. Due to the SinCRECS quality and compound nature, the typical high-concentration related emission quenching in traditional doped materials is dramatically reduced or eliminated.

Potential Applications

- High power laser manufacturing
- Materials processing
- Medical lasers (eye surgery)
- Environmental systems
- Scientific instrumentation

Benefits and Advantages

- Increased Performance – Higher optical gain and better photoluminescence properties than any other RE-based material
- Longer Lifetime – Eliminates a major cause of material degradation to increase the lifetime of materials.
- Improved Uniformity – Increased homogeneity of RE-ion distribution improves laser performance

- More Precision – Control RE-ion density more precisely for specific applications of the laser
- Lower Cost – Technique is able to produce large enough volumes of materials for high power applications at a lower cost

For more information about the inventor(s) and their research, please see

Dr. Cun-Zheng Ning's directory webpage