The Ceramic Society of Japan
Cross-cutting Research Group

Random Laser Science and Technology

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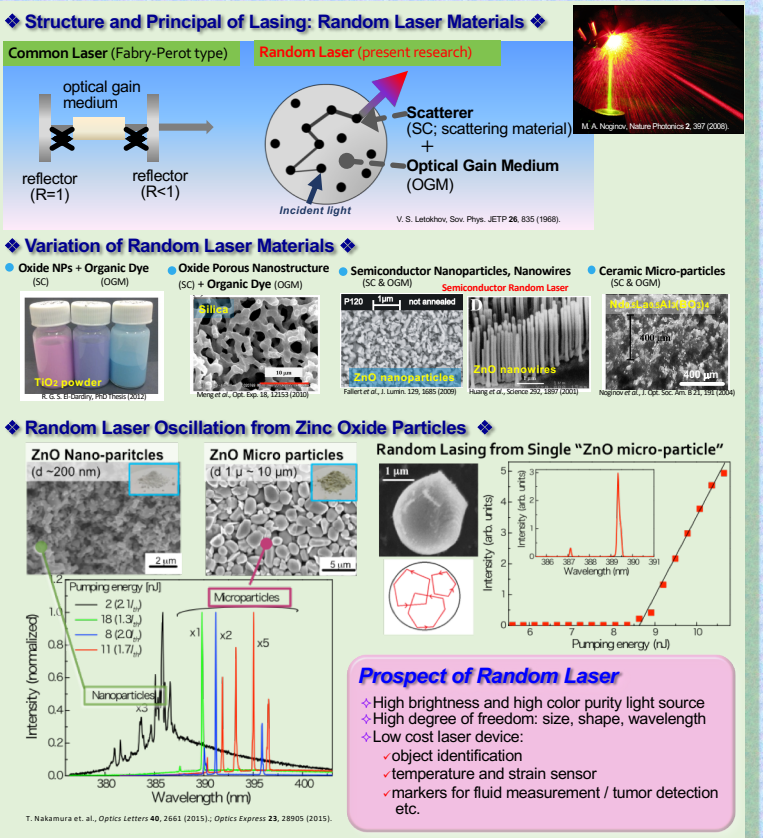
What's a Random Laser?

In an aggregate or structure composed of nano/micro particles having a non-uniform shape of about the wavelength of incident light, random strong light scattering occurs. Combining such a "scatterer" structure (abbreviated as *SC*) with an "optical gain medium (material) (*OGM*)" is known to exhibit a laser oscillation phenomenon under high-density optical excitation. Such a laser is called a "**Random Laser**". The random laser has attracted attention as a simple laser light source, because it does not require precisely-controlled resonators which conventional laser system always need.

Many random laser materials (systems) have been demonstrated and studied, *see Figures,* such as oxide nanoparticles and luminescent organic dye molecules, porous nanostructured oxide ceramic and organic dye, ceramic microparticles, and wide-gap semiconductor nanoparticles/nanorods, etc. For example, zinc oxide (ZnO) particles aggregate, nanoparticles, or nanorods serve both as a scatterer (SC) and an optical gain medium (OGM), resulted in the lasing UV light (Figures).

Although the random lasing phenomenon has been confirmed in various material systems such as ceramics/semiconductors, there are still unclear or unsolved issues regarding the exact understanding of the theory, elucidation of oscillation mechanisms, and design and creation guidelines for materials and structures from the viewpoint of academic knowledge and engineering applications.



Prospect of Random Laser

- High brightness and high color purity light source
- High degree of freedom: size, shape, wavelength
- Low cost laser device:
  - object identification
  - temperature and strain sensor
  - markers for fluid measurement / tumor detection etc.

Aim of the Research Group

Therefore, with the aim of further development through the complementary fusion of random laser and ceramics science and technology, we have launched-up a cross-cutting research group that covers the various academic fields <materials science, physics, optics, chemistry etc>, that serve as the basis for the random laser and related phenomenon. To achieve the goals, we will enforce meetings/workshops, support specific joint research and the promote industry-academia/industry-government-academia corroborations.

Topics

This cross-cutting research group covers a wide range of topics relating to random laser science and technology including, but not limited to:

Principle and basic physics of random laser

- Control of oscillation mode (single/multi) and wavelength
- Lowering lasing threshold
- Analysis and elucidation of the laser properties
- Light scattering phenomenon
- Luminescent transition rate (lifetime)
- Quantum efficiency
- Correlations with micro/nano structure

Materials for random laser

- Design, control and fabrication of ceramic structure (porous ceramics, micro/nano-particles, aggregates)
- Survey of materials for optical gain medium / scatterer
- Micro- and nano-structure design and synthesis
- Tuning and analysis of physical properties for lasing
- Geometric shape control and effects of materials on lasing
- Device design and fabrication

Activities

- Research meetings/workshops (information exchange).
- Networking of related researchers, engineers and societies.
- Collection of related information (domestic and overseas).
- Information dissemination (announcements at academic conferences/symposiums, publishing research results, publishing trends as review/commentary in societies magazines, etc.).
- Planning and implementation of joint research (& support) among academia, industry and government.
- Acquisition of research funds by related parties, etc.

[Past & Upcoming Meetings]

- Start-up meeting (Sept. 6, 2019, at Hosei University, Tokyo).
- The workshop/meeting will be planned independently or as a satellite meeting in domestic a/o international conferences organized by the related societies.

[Related Activity (research group)]

- High Density Excited Nano/Micro Optical Material Research Group (Established in Dec. 2018).

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Random Laser JAPAN