Docket #: S19-291

Chip-integrated Titanium:Sapphire Laser

Stanford researchers at the Vuckovic Lab have developed a full chip-scale integration of a Ti:Sapphire laser system which dramatically reduces the size, cost, and power consumption by many orders of magnitude, compared to today's state-of-the-art systems which are bulky and expensive. The proposed architecture is a microscale Ti:Sapphire laser system, which converts an inexpensive infrared diode light into ultrafast pulses.
Miniaturization and integration with on-chip photonics can revolutionize the field of photonics and have a major impact on many applications, including two-photon microscopy, LIDAR systems and quantum photonics.
The process flow for fabricating this new Ti:Sapphire laser system is similar to the demonstrated technique for fabricating Silicon-Carbide-on-Insulator (SiCOI) devices disclosed in Stanford docket S18-553.

Figure

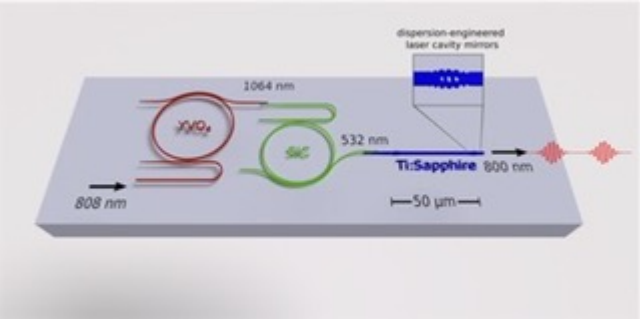


Figure description - Conceptual figure representing on chip integrated Ti:sapph laser of size on the order of 100 um. Combined with a commercial diode pump, its volume is smaller than one cubic centimeter – many orders of magnitude smaller than the state of the art.

Stage of Development - Proof-of-Concept

Applications

- **Broad applications** including spectroscopy, bio-medical and physics research
- **Specific examples include:**
  - LiDAR
  - Two photon absorption imaging
  - Optical clocks
  - Integrated quantum photonic devices

Advantages

- **Ti:Sapphire is desirable** due to its very wide bandwidth and operation as a wide-range (up to 650-110nm) tunable coherent source thus as a ultra-fast pulsed light
- **Miniaturization and chip-scale integration:**
  - Dramatically reduces the size, cost, and power consumption by many orders of magnitude
  - Current state-of-the-art systems are bulky and expensive
- **Compact device** - 1000's of times smaller than state of the art
- **Environmentally robust**
- **Ultra-low threshold powers** are possible because of small mode volume and enables battery-powered operation
- **Low-temperature operation** by integrating chip with thermoelectric cooling and further decreases threshold powers by improving efficiency of Ti3+ radiative decay
- **Low cost of materials** for individual Ti:Sapphire laser (less than $100)
- **Direct integration** with portable and on-chip applications
- **Standard fabrication methods** with standard photo and e-beam lithography and standard nanofabrication tools

Patents

- Published Application: WO2021022188
- Published Application: 20220278497

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