RX15-12

1. **Research Title:** High Power Waveguide Lasers by Dual Beam Pulsed Laser Deposition
2. **Individual Sponsor:** List the AFRL research topic sponsor's contact information

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3. Academic Area/Field and Education Level

Field and Education Level: Graduate student in materials science/materials engineering/phyisics/optics (MS or PhD level)

4. **Objectives:** The goal of this research is to develop efficient, compact, lightweight, high power planar and channel waveguide lasers from highly aligned ceramic materials including garnets, vanadates and rare earth sesquioxides. Pulsed laser deposition (PLD) will be used to grow thin film planar waveguides . Channel waveguides will be grown with PLD performed on templated substrates with channels produced by femtosecond laser micromachining. Multi-beam, multi-target PLD will be used to deposit graded layers for tailored refractive indices, tailored thermal expansion coefficients, and graded doping for control of mode behavior.
5. **Description:** Pulsed laser deposition will be used to form waveguide laser structures. Multilayer growth is accomplished by depositing films from different targets in-situ. Layer thicknesses can easily be chosen as required by changing the deposition time or laser repetition rate. Materials can be chosen based on crystal structures and compositions that are compatible with the requirements for achieving growth of highly aligned ceramic films. Additionally, dual laser beam, dual target pulsed laser deposition allows for materials blending and doping for additional functionality. This is accomplished by the blending of two plasma plumes that are simultaneously evaporated from two different targets.

AFRL/RXAP has a new dual beam, dual target PLD system for performing this task [1]. In addition, laser substrate heating has been incorporated so that thin films can be grown at 1000°C which is necessary for highly crystalline growth. In particular, sesquioxides (Lu_2O_3, Y_2O_3) are challenging to due to their high melting points (>2400°C), however they make ideal laser host materials due to their high thermal conductivity, mechanical stability, and can be easily doped with rare earth ions. Garnets such as YAG, YIG, GGG,and GSGG are excellent laser hosts which can be easily mixed using our dual laser beam / dual target PLD system to make films with tailored properties, such as defined lattice constant or refractive. Characterization of the material properties of graded layers will be conducted in-house in AFRL/RXAP with SIMS (measurement of atomic percentages) and XPS (valance states of dopants). Optical characterization will include modal analysis, propagation loss, laser threshold, slope efficiency and beam quality (M2).

[1] R.W. Eason, et al. *Applied Surface Science* 255 (2009) 5199–5205

6. **Research Classification/Restrictions:** none
7. **Eligible Research Institutions:** Indicate to what organizations this topic should be provided

DAGSI (Wright State University, AFIT, Ohio State University, University of Dayton, Miami University, Ohio University, University of Cincinnati) NOTE: Topics submitted to DAGSI must be approved for public release. **Need PA Approval #** 88 ABW-2014-3168