Project Title: Numerical modeling of laser-plasma interaction in plumes induced by pulsed laser irradiation of tungsten targets

Project Reference Code: Volkov-UA

Name of Project Leader: Alexey Volkov

Host Facility: University of Alabama, Tuscaloosa

Internship Location: South Engineering Research Center (SERC), Hardaway Hall (HR)

Host Facility Location: 7th avenue, University of Alabama, Tuscaloosa, AL 35487

Project Description (roughly 300 words):
The refractory metals such as tungsten are pivotal materials for a number of industries from aerospace applications to nuclear fusion. This project is targeted at revealing the major mechanisms of laser-plasma interaction in plasma plumes induced by processing of tungsten targets with pulses of high-powder laser radiation. Computational studies of such problems required hybrid computational models that include the models of heating materials by lasers, material removal from the irradiated surface, plasma plume expansion, and radiation transfer. The project includes an educational component targeted at understanding all these models. The simulations will be performed with an MPI-parallelized C/C++ computational code, developed in the research group of the host faculty. The core of this code is the direct simulation Monte Carlo (DSMC) method for kinetic simulations of gas and plasma flows. The project requires minimum C/C++ programming skills. The simulations will be targeted at revealing the non-equilibrium effects and effects on laser wavelength om laser-plasma interaction. During the internship term, the host will be out of office for conference trips that can take totally 2-3 weeks. During this time, the intern is expected to work on the project and communicate with the host via e-mails and Zoom meeting.

Disciplines: Engineering, physics

Importance:
The project is relevant to multiple applications of lasers for material processing applications such as pulsed laser ablation, pulsed laser deposition (PLD) of functional thin films, and laser powder bed fusion additive manufacturing.

Requirements:

- Preferred Major
  - Physics, Mechanical Engineering, Aerospace Engineering, Chemical Engineering.
- Class work
  - Basic physics, Calculus + differential equations.
- Programming knowledge
  - C/C++ is preferable.
- Software knowledge
  - Basic Linux is preferable. Tecplot (r) will be used for visualization of the simulation results, but preliminary knowledge of Tecplot is not required.

Biography (roughly 100-150 words):
Alexey Volkov is an Associate Professor in the Department of Mechanical Engineering (ME) at the University of Alabama, where he has worked since 2013. He received his M.S. degree in Aerospace Engineering from the Baltic State Technical University (Russia) in 1993, M.S. degree in Applied Mathematics from the St. Petersburg State University (Russia) in 1995, and Ph.D. degree in Fluid Mechanics from the St. Petersburg State University in 1996. He published 72 papers in peer-review journals, 41 papers in conference proceedings, 5 book chapters, and 3 textbooks, and co-authored 26 invited talks. His research interests are related to problems that require multiscale and multi-physics computational approaches and high-performance computing, including rarefied and two-phase gas dynamics; laser-material interaction and laser ablation; metal-based additive manufacturing; mechanical, thermal, and thermoelectric properties of carbon nanotube materials and ceramic heterostructures; gas-assisted technologies of material fabrication; as well as dynamics of upper planetary atmospheres.

Is U.S. citizenship required to participate in this project? No.

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