INSTITUT FRANCO-ALLEMAND DE RECHERCHES DE SAINT-LOUIS

Adresse postale en France :
Boîte postale 70034
68301 SAINT LOUIS CEDEX
France

DEUTSCH-FRANZÖSISCHES FORSCHUNGSINSTITUT SAINT-LOUIS

Postanschrift in Deutschland:
Postfach 1260
79547 Weil am Rhein
Deutschland

Siège/*Sitz :* 68300 SAINT-LOUIS - France - 5 rue du Général Cassagnou - Tél. +33 (0)3 89 69 50 00 - Fax +33 (0)3 89 69 50 02 - E-mail : isl@isl.eu - Web : www.isl.eu

RIM – Radiation Interaction with Matter

Internship proposal

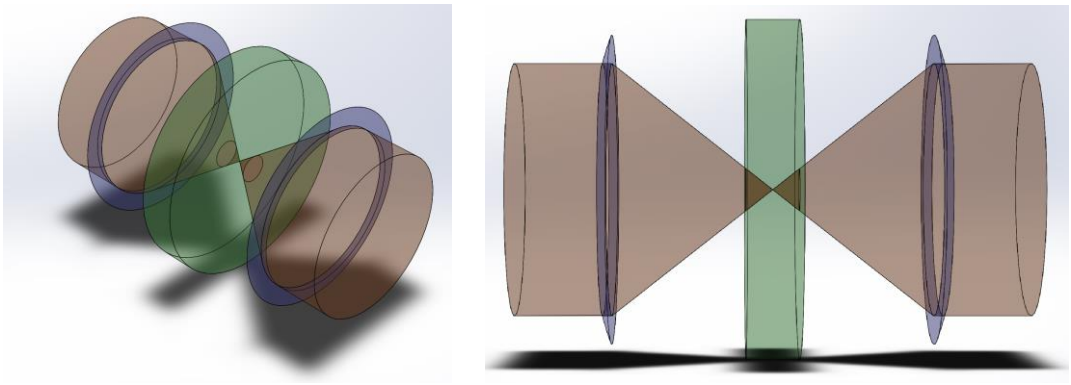
Simulations of heat dynamics induced by a laser irradiation with COMSOL Multiphysics

21/11/2019

The RIM group's main purpose is to study the behavior of various materials under both jamming (low energy) and assault (high energy) laser irradiations from an experimental as well as a modeling point of view. Developing multiphysics Finite Elements simulations to compute any possible scenarios thus requires a complete understanding of the several optical, thermodynamical and mechanical phenomena involved during a laser irradiation.

Internship supervisor: Olivier Muller

The first part of this internship deals with the modeling of fast thermal effects in polymer optical filters induced by a very-quick but intense laser pulse (532 nm, 4 ns, 200-2000 J/cm²). Whereas the material shows a low absorption coefficient, it can be considered as an absorbing media from a microscopic scale, at which heat transfer mainly driven by thermal conduction can occur.



Heat source distribution within the filter

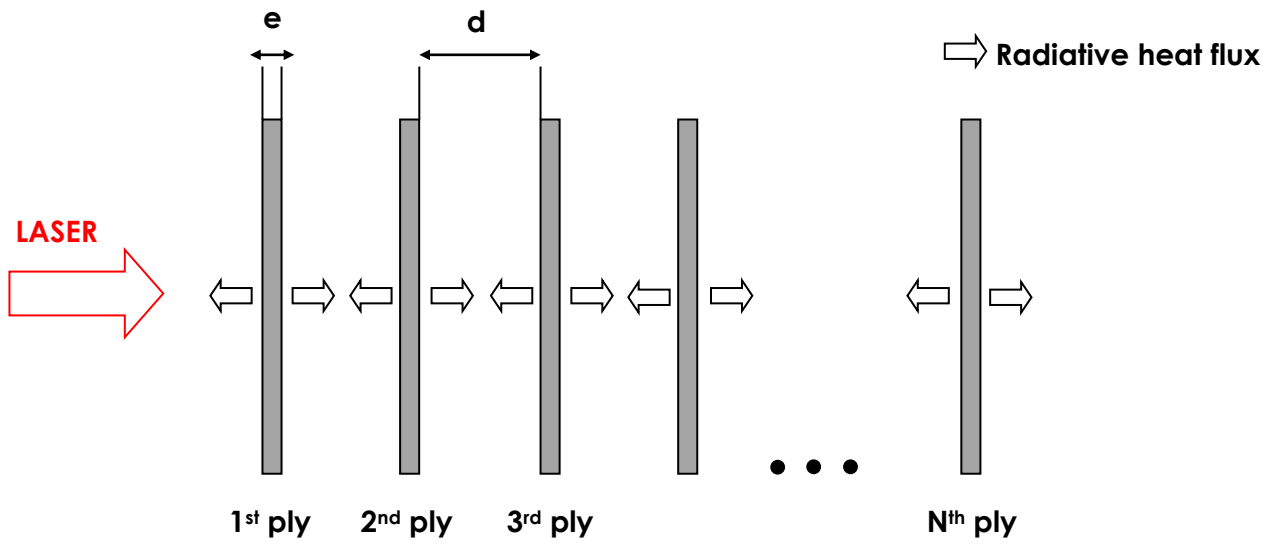
Tasks breakdown

1- Assessment of the thermophysical parameters required for thermal modelling at the wavelengths of 532nm, 1064nm, 2µm (bibliographic review or experimentally)
2- Thermodynamical characterization of homogeneous polymers using laser flash experiments and/or thermal conductivity analysis
3- Implementation of the geometry within COMSOL, and simulations of series of senarios.
4- Validation of the model(s) using experimental data

Internship supervisor: Vadim Allheily

The second part of this work is to set up some models to compute the heating of composite systems submitted to a high-energy continuous irradiation (1070 nm, 1-10 s, 20-2000 W/cm²). Carbon and glass fibers reinforces polymers are concerned, and thermal conduction, convection and radiation

are involved. The use COMSOL Multiphysics is considered to be able to take into account the laser beam propagation within the material, the temperature dependant properties of the composite and the degradation of the polymer. Some experimental work with a huge amount of lab activities (using spectrometers, pyrometers, thermocouples and other devices) is also foreseen to adjust and to validate the obtained numerical results.



Work plan:

1. Bibliographic review about numerical simulations and material properties
2. Setup of some basic Comsol models (numerical validation of the methodology)
3. Thermodynamical characterization of the samples using various methods (calorimetry, Laser-Flash analysis, Modified Transient Plane Source,…)
4. Instrumentation of samples and contribution to laser experiments in the lab
5. Development of Comsol models and comparison with experimental results

POCs:

- Vadim Allheily (03.89.69.53.54 – vadim.allheily@isl.eu)
- Olivier Muller (03.89.69.58.59 – olivier.muller@isl.eu)
- Lionel Merlat (03.89.69.53.78 – lionel.merlat@isl.eu)