UNIVERSITÀ DI TRENTO | Department of Physics

A Quantum of Matter

Impulse generation by confined laser ablation: polymers and thin films

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When an intense laser pulse impinges on the surface of a material, some mass ejection is observed, a phenomenon known as laser ablation. Due to the high velocities of the ejected material, of the order of $\sim$ km/s, a measurable impulse is generated on the irradiated material, so that laser ablation recently gained interest as a possible space propulsion technique. This possibility became increasingly attractive with the advent of large constellations of nanosatellites and with the emerging problem of space debris mitigation, since both these applications require to control far objects that can not bring on board a propulsion system. To make laser ablation propulsion (LAP) applicable to nanosatellite propulsion, it is fundamental to understand the processes involved in the impulse generation process, in order to develop optimized target materials for this purpose. To this aim, optical coupling of the material with the laser can be optimized, while a consistent enhancement of generated impulse can be obtained by confining the expansion of the ablation plume in vacuum using a transparent layer. Confined laser ablation therefore can be a possible solution for nanosatellite propulsion. By exploiting a specifically designed ballistic pendulum [1] to measure laser generated impulse, confined ablation was studied in the case of composite polymeric materials and in case of thin film confinement. Results on composite polymers show that it is possible to obtain structures in which the interaction with the laser pulse results in the spontaneous formation of a confinement layer [2]. On the other hand, investigation of systems with thin confinement layers allowed to highlight some general features of the impulse generation process exploiting this kind of geometry.

[1] *P. Battocchio et al. "Ballistic measurements of laser ablation generated impulse", Measurement Science and Technology 32, 015901 (2021).*
[2] *P. Battocchio et al. "Improved laser ablation propulsion efficiency in composite polymers, containing reduced graphene oxide, by the spontaneous formation of a confining layer", Applied Surface Science 687, 162251 (2025).*

Who is Pietro Battocchio?
Pietro Battocchio obtained his PhD at the University of Trento working on polymeric systems for laser ablation propulsion. Since 2023 he is a postoctoral researcher at the same university. His research activity focuses on laser matter interaction and the development of materials for laser ablation propulsion.

A Quantum of Matter is a series of events dedicated to the research in Physics of Matter that is carried out in the **Physics Department of the University of Trento**. The goal of **A Quantum of Matter** is to develop synergies and collaborations between research groups: for this reason, the seminars will focus not only on the results obtained, but also on the techniques employed by the groups and on the possible research themes that could be developed in partnership, leaving plenty of room for exchange of opinions and discussion.

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