Proceedings of the Canadian Society for Mechanical Engineering International Congress
32nd Annual Conference of the Computational Fluid Dynamics Society of Canada
Canadian Society of Rheology Symposium
CSME-CFDSC-CSR 2025
May 25–28, 2025, Montréal, Québec, Canada

Ultrafast laser processing: Developments in texturing and micromachining

Arnaud Weck
Mechanical Engineering Department, University of Ottawa, Ottowa, Canada
*aweck@uOttawa.ca

ABSTRACT

Ultrafast lasers have emerged as a powerful tool for advanced manufacturing. Their short pulse duration, high peak power, and high repetition rate enable high-precision processing over large areas while minimizing damage to surrounding material.

In this talk, I will present recent work from my research group on ultrafast laser-induced material modifications for colour generation, and micromachining across various materials.

I will demonstrate how laser-generated nanoscale surface structures can produce vivid colours on silver and copper through a complex interplay of surface morphology, chemistry, and plasmonic activation. Similarly, ultrafast lasers were used to tailor the optical response of polymer nanocomposites, generating structural colours within the bulk by activating surface plasmons at embedded nanoparticles.

Beyond colouration, ultrafast lasers provide precise control over material removal, from precision cuts to the creation of deep grooves and high-aspect-ratio features. We successfully micromachined ultrathin, free-standing silicon nitride (SiN) membranes with sub-micron precision, fabricating patterns that serve as high-Q resonators that rival those produced in cleanroom environments. I will also discuss the challenges involved in machining high aspect ratio features in metals, highlighting the crucial role laser polarization plays in achieving smooth and straight cuts.

I will conclude by discussing the broader impact of ultrafast laser technologies, particularly their potential applications in material processing to support a more sustainable environment.