Séminaire PIMM
Jeudi 09 juillet 2015 à 14h
Amphi Bézier
Arts et Métiers ParisTech, 151 bd de l'hôpital, 75013 Paris

14h00
Damien Courapied - Doctorant PIMM
Etude de l'interaction laser matière en régime de confinement par eau avec deux impulsions laser. Application au test d'adhérence par choc laser.

Aujourd'hui, une grande partie des matériaux de la vie courante sont revêtus. Les systèmes barrières thermiques (BT), utilisés dans les turbines aéronautiques, sont des systèmes multicouches composés d'un substrat en superalliage monocristallin, d'une sous-couche d'alliage alumino-formeur sur laquelle se forme une couche d'alumine, initiée pendant le procédé de fabrication. Le tout est revêtu d'une couche en zircone, la barrière thermique, qui permet de diminuer la température de travail du substrat. Les systèmes BT sont soumis à des contraintes thermomécaniques qui créent des endommagements, en particulier aux interfaces. La caractérisation des interfaces substrats-revêtements est donc un enjeu majeur. C'est dans ce cadre que la technique LASAT (Laser adhesion Test) a été développée. La caractérisation des interfaces dépôt-substrats par laser a été développée et validée depuis plusieurs années. Le principe de base du test de décohésion, ou LASAT est basé sur la formation d'un chargement mécanique locale intense au cœur des matériaux. Ce chargement est généré grâce à des choc-lasers par croisement d'ondes de détentes incidentes et réfléchies. Néanmoins cette technique montre ses limites pour solliciter des dépôts épais (> 50um).
L'amélioration de la technique LASAT est donc basée sur l'utilisation de deux chocs. Le décalage entre ces deux ondes de choc, contrôlé grâce au décalage temporel entre les deux impulsions laser incidentes permet de localiser le chargement mécanique, par exemple à l'interface d'un système dépôt-substrat. Ainsi, cette nouvelle technique permet de solliciter des systèmes comportant un dépôt de forte épaisseur (> 50 µm) réalisé par projection thermique.

14h35
John Lopez -Ingénieur de Recherche CNRS –Université Bordeaux 1 CELIA
Part I : ABLATION EFFICIENCY OF HIGH AVERAGE POWER ULTRAFAST POWER

Nowadays the relevance of ultrashort laser is well established for many medical or industrial applications. Indeed, the ultrashort laser technology has reached a high level of robustness which makes it compatible with the needs of industry. This laser technology combines the unique capacity to process any type of material with an outstanding precision and a minimal heat affected zone. Thanks to high average power and high repetition rate it is possible to achieve high throughput providing that the operating parameters are finely tuned to the application, otherwise heat accumulation and heat affected zone may appear.
This presentation deals with high throughput single pass ablation of stainless steel with a high average power Yb-doped fiber ultrashort pulse laser which is tunable in pulse duration from 350fs to 10ps and in repetition rate from 200kHz to 2MHz. The influence of pulse duration, repetition rate, fluence, energy dose and scanning velocity will be discussed in terms of ablation efficiency and processing quality. These results will be compared to those previously obtained on Aluminum, Copper and Molybdenum. We will see that the effect of these parameters is strongly material dependent. The ablation behavior of stainless steel is very sensitive to these parameters meanwhile it is not the case for Aluminum in the investigated process window. We observe an intermediate behavior for Copper and Molybdenum. Moreover, we will demonstrate that engraving of metals without melt formation is possible even at high average power (20W) and high repetition rate. Furthermore, best ablation efficiency and quality are obtained at low fluencies. Scaling up from 2W to 15W implies to use high repetition rate and high deflection velocity.

Part II : TREPANNING DRILLING OF STAINLESS STEEL USING A HIGH-POWER YTTERBIUM-DOPED FIBER ULTRAFAST LASER

Percussion drilling is a well-established technique for several applicative markets such as for aircraft and watch industries. Lamp pumped solid state lasers and more recently fiber lasers, operating in millisecond or nanosecond regimes, are classically used for these applications. However, due to their long pulse duration, these technologies are not suitable for emerging applicative market such as fuel injectors for automotive industry. Only the ultrashort laser technology, combined with special drilling optics like trepanning head, has the potential to fulfill the needs for this new market in terms of processing quality, custom-shape capabilities and short drilling time. Although numerous papers dealing with percussion drilling have been reported in the literature, only few papers are dedicated to trepanning drilling. In this context, we present some results on the influence of pulse duration on gas-assisted laser drilling of stainless steel using a trepanning head and a high power Ytterbium doped fiber ultrafast laser (20W). The influence of pulse energy (7-64µJ), fluence (3-25 J/cm²), drilling time (1-20s), processing gas pressure and drilling strategy will be discussed as well.

15h30
Café