THALES

Latest results in Laser Shock Peening (LSP)

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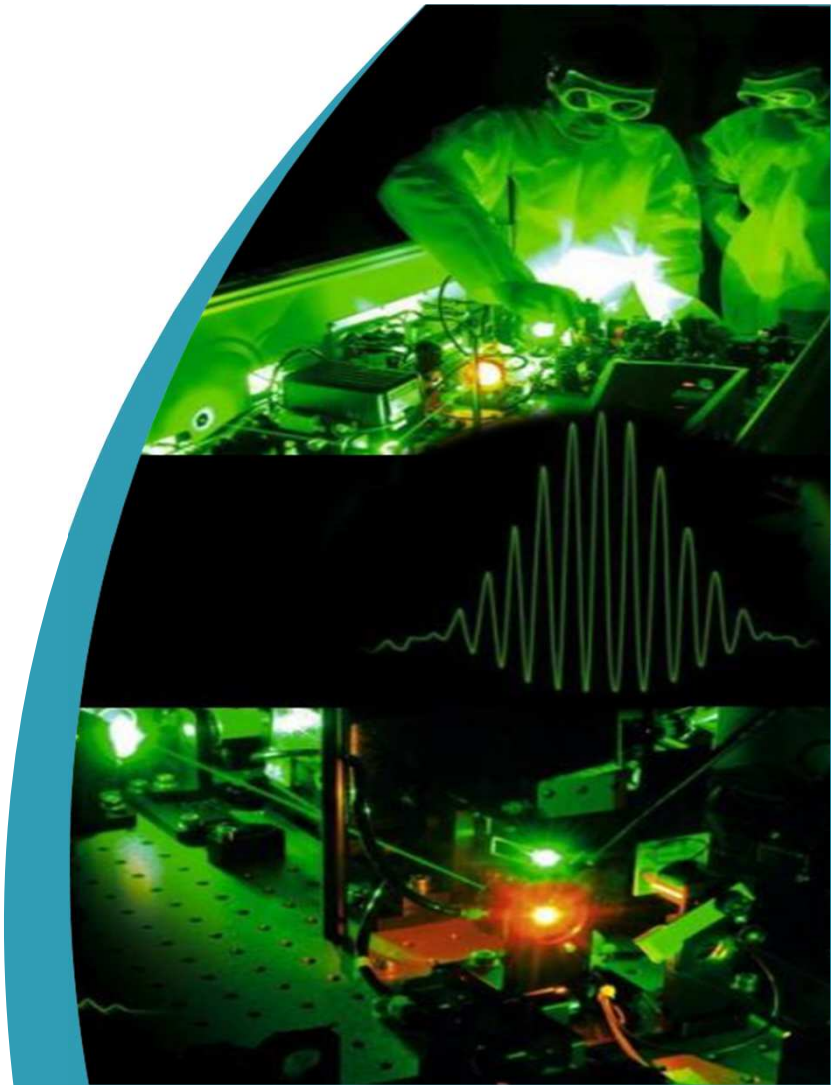
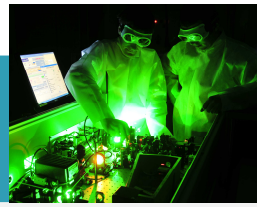
14 December 2020

EPIC online technology meeting on industrial laser manufacturing for naval and aeronautic applications



Laser markets & applications



SCIENCE

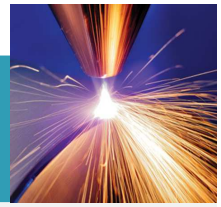
- Particle acceleration
- HED science

ELI-NP
2 x 10 PetaWatts

PKU 200TW/5Hz

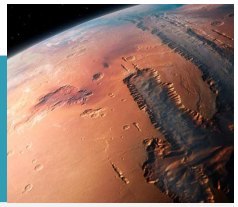
RIKEN 2x 500TW/1Hz

BELLA 1.3PW/1Hz



INDUSTRY

- Laser peening
- Semiconductor industry
- CFRP material processing



SPACE

- LIBS
- LIDAR
- Satellite ranging
- Space debris removal

Curiosity rover on Mars since 2012 (joined by Perseverance 2021)

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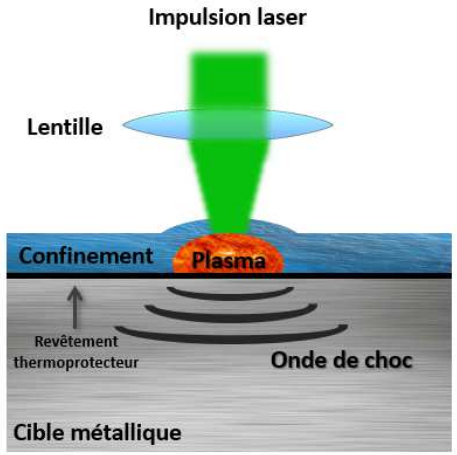
Laser shock peening

Generation of a high-pressure plasma (>GPa) by focusing a high-energy pulsed laser

- 1-10 J ; 5-15 ns ; 3-5 mm → GW/cm²

- Possible applications :

  →LSP (Laser Shock Peening)
  →LASAT (LAser Shock Adhesion Test) ≡ LBI (Laser Bond Inspection)
  →LS (Laser Stripping)
  →Materials characterization



Thales activities in the LSP field

- Joint PhD work with PIMM laboratory @ ENSAM Paris on LSP process for laser parameters optimization
- R&T collaborative projects at French level (FUI « MONARQUE » / ANR « FORGE LASER » / ANR « TRANSFUGE »)
- Development of laser products suited for LSP

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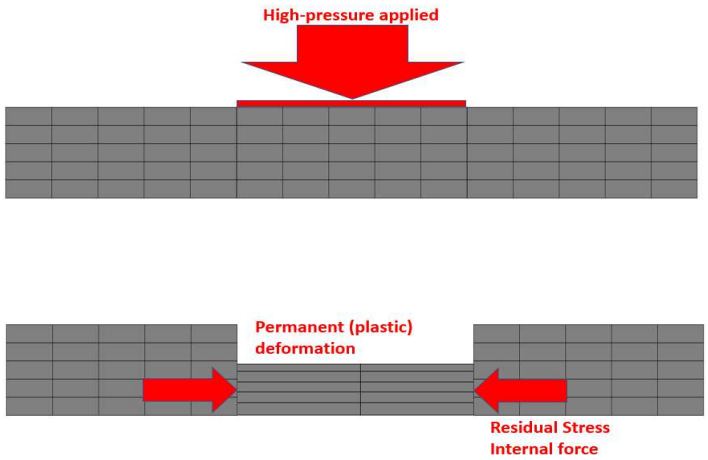
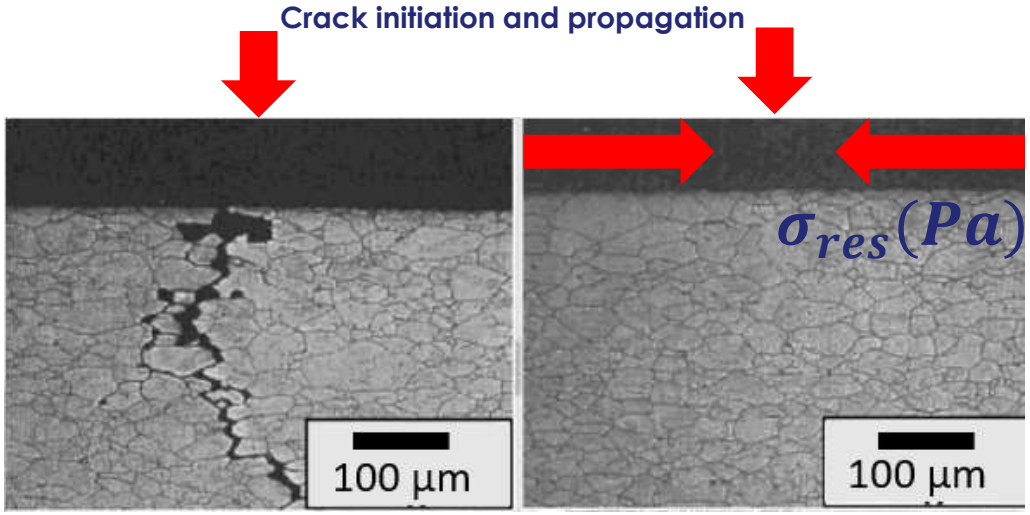
How does LSP improve the fatigue life of treated parts

Objective: To induce permanent deformation in depth of the metal by using a high-pressure shock wave





Without LSP VS With LSP

Résult: - lifetime of the treated part up to X5
- Resistance to corrosion

/!\ Without thermal coating, we sould have $\sigma_{res} > 0$ at the surface: it helps cracks to propagate

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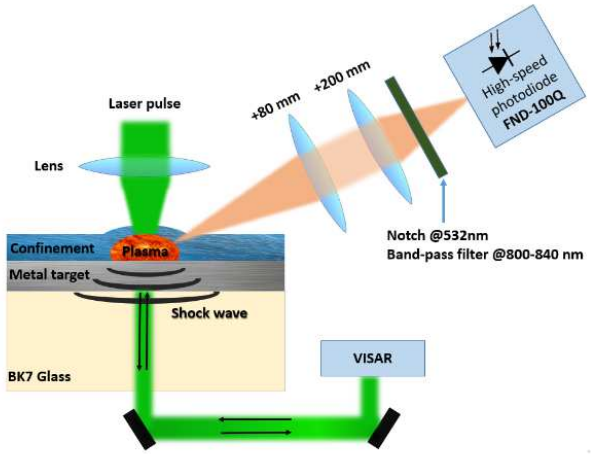
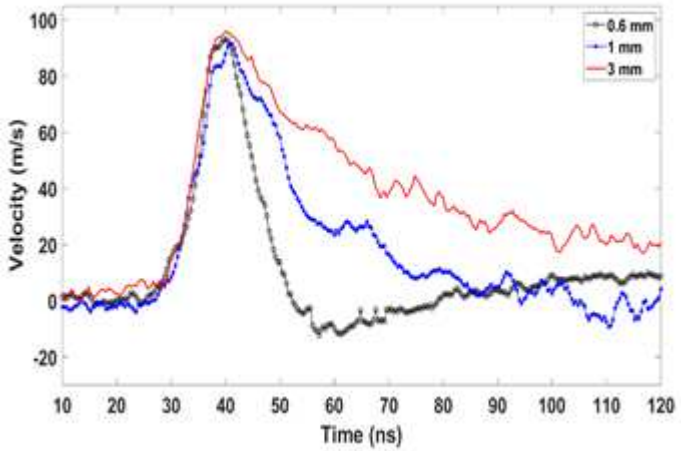
Laser peening results as a function of laser spot size

(Latest results of Alexandre Rondepierre PhD work in collaboration with PIMM lab @ ENSAM Paris)





- **VISAR measurements :**
  - → rear (not free) surface velocities
    - → shock waves temporal profile
      - → plasma pressure temporal profile
- **Radiant intensity measurement** with high-speed photodiode
  - → plasma temperature temporal profile (Planck's law)

The loading (rising part) is independent of the spot size

The release (falling part) clearly shows a dependency with the spot sizes : as smaller it is, as shorter is the release

→ **Reduction of thermal loading in the material**

For more details:
A.Rondepierre et al.
Beam size dependency of a laser-induced plasma in confined regime: Shortening of the plasma release. Influence on pressure and thermal loading
https://doi.org/10.1016/j.optlastec.2020.106689

Potential laser products for LSP

THEIA specifications

Specifications

Version	IR	Green	UV
Wavelength (nm)	1064	532	355
Repetition rate (Hz)	Up to 200		
Energy per pulse (mJ)	1000	700	500
Pulse to pulse energy stability (% rms)	< 1.0		
Typical pulse width (ns)	10		

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Thank you for your attention