The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5 – 9 June 2022, Oslo, Norway

ANALYTICAL COMPUTATION OF SHOCK WAVE STRESSES CAUSED BY LASER PLASMA IN A MATERIAL INTERFACE – APPLICATION TO PAINT STRIPPING ON ALUMINUM SUBSTRATES

Kosmas Papadopoulos[1] and Konstantinos Tserpes[2]

[1] Laboratory of Technology & Strength of Materials, Department of Mechanical Engineering & Aeronautics, University of Patras, Patras 26504, Greece
[2] Laboratory of Technology & Strength of Materials, Department of Mechanical Engineering & Aeronautics, University of Patras, Patras 26504, Greece

Key Words: *Shock wave stresses, Laser shock stripping, Finite element analysis*

In the present work, an analytical model has been developed to calculate shock wave stresses caused by laser plasma in a material interface. The input pressure causing the shock wave has been derived from a laser-matter interaction model [1]. The material velocity, stresses, and strains versus time in the two materials and the interface have been computed by solving the jump equations for conservation of mass and balance of momentum [2]. The material interface has been considered as an immovable boundary while the back free surface as an unrestrained boundary. The model has been used for the fast computation of interfacial stresses causing paint stripping on aluminum substrates [3] and the subsequent fast assessment of stripping initiation. The effects of laser intensity, yield stress and Poisson's ratio of the epoxy (paint) on the interfacial stresses have been studied. A validated 3D FE model of the laser shock wave propagation in the aluminum/epoxy system developed in the LS-Dyna [4] has been employed to validate the analytical model. The interfacial stresses have been computed using contact element. The analytical results correlate relatively well with the numerical ones. The refinement of the analytical model and its exploitation to the laser shock paint stripping technological problem is still in progress.

REFERENCES

[1] R. Fabbro, J. Fournier, P. Ballard, D. Devaux and J. Virmont, Physical study of laser-produced plasma in confined geometry. *J. Appl Physics*, Vol. **68**, 775, 1990.

[2] L. Davison, *Fundamentals of Shock Wave Propagation in Solids*, Springer-Verlag Berlin Heidelberg, 2008.

[3] S. Ünaldi, K. Papadopoulos, A. Rondepierre, Y. Rouchausse, A. Karanika, F. Deliane, K. Tserpes, G. Floros, E. Richaud and L. Berthe, Towards selective laser paint stripping using shock waves produced by laser-plasma interaction for aeronautical applications on AA 2024 based substrates. *Optics, Laser & Technology*, Vol. **141**, pp. 107095, 2021.

[4] K. Tserpes, K. Papadopoulos, S. Unaldi and L. Berthe, Development of a Numerical Model to Simulate Laser-Shock Paint Stripping on Aluminum Substrates. *Aerospace*, Vol. **8**, 233, pp. 1-16, 2021.