

# Taking into account thermal constraints in topology optimization of structures built by additive manufacturing

Grégoire Allaire<sup>1</sup>, Lukáš Jakabčín<sup>2</sup>

<sup>1</sup> Centre de Mathématiques Appliquées, École Polytechnique, 91128 Palaiseau, France,  
gregoire.allaire@polytechnique.fr,

<sup>2</sup> Centre de Mathématiques Appliquées, École Polytechnique, 91128 Palaiseau, France,  
lukas.jakabcin@polytechnique.edu.

**Keywords:** *Additive manufacturing, Thermal residual stresses, Shape optimization.*

In this talk, we introduce a model and several constraints for shape and topology optimization of structures, built by additive manufacturing techniques. The goal of these constraints is to take into account the thermal residual stresses or the thermal deformations, generated by processes like Selective Laser Melting, right from the beginning of the structural design optimization.

In other words, the structure is optimized concurrently for its final use and for its behavior during the layer by layer production process. It is well known that metallic additive manufacturing generates very high temperatures and heat fluxes, which in turn yield thermal deformations that may prevent the coating of a new powder layer, or thermal residual stresses that may hinder the mechanical properties of the final design.

Our proposed constraints are targeted to avoid these undesired effects. Shape derivatives are computed by an adjoint method and are incorporated into a level set numerical optimization algorithm. Several 2-d and 3-d numerical examples demonstrate the interest and effectiveness of our approach.

## REFERENCES

- [1] G. Allaire and L. Jakabčín, *Taking into account thermal residual stresses in topology optimization of structures built by additive manufacturing*. submitted. HAL preprint: hal-01666081, 2017.