# Università degli Studi di Pavia

## Dipartimento di Meccanica Strutturale

**In collaborazione con**

**Centro di Simulazione Numerica Avanzata – CeSNA**

**Istituto Universitario di Studi Superiori**

SEMINAR

# Experimental study and numerical modeling of phase transformation and viscoplastic behaviour of TA6V: Application to laser welding and laser prototying


The presentation has three parts: the characterization of phase kinetics for complex temperature histories; the determination of the relevant viscoplastic constitutive equations in presence of phase changes; the use of the previous models for the evaluation of residual stresses in two industrial processes.

The metalllurgical model is able to describe the phase evolution. It takes into account three phases, a, a' and b. The influence of vanadium diffusion is also considered. The evolution can be computed for any type of temperature history, as it is given by a differential system that can be easily integrated in any type of software.

Viscoplastic behaviour is described by means of a mean field model, where each phase is represented by its own viscoplastic potential involving kinematic and isotropic hardening, with a recovery effect. A scale transition rule allows to compute the local stresses in each phase as a function of the macroscopic stress and viscoplastic strain, and of the local viscoplastic strain. The model is implemented in a finite element code, using a robust implicit scheme that provides the tangent matrix.

Simplified assumptions are adopted for the industrial applications. It is supposed that the temperature fields do not depend on the phase history and the mechanical state. On the other hand, there is a strong coupling between metallurgy and mechanics: the amount of phases is then determined together with the mechanical calculation. The first case is laser welding. The second one is laser prototyping: here, the component is formed by a projection of powder that is melted on the flight by a laser beam, so that the final shape is well respected. For each case, the finite element simulations provides the residual displacement, that is in good agreement with the experimental measurements. It gives also maps of residual stresses and of the local phase distribution.



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