TRANSVALOR

Process simulation software applied to the medical sector

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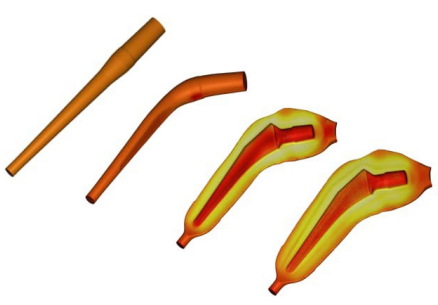
ABSTRACT: Transvalor's software portfolio offers a large range of applications dedicated to the MedTech sector. Forging & Casting of implantable medical devices such as prosthesis can be modeled with FORGE® and THERCAST® software. FEM modelling helps to anticipate manufacturing defects and shorten compliance procedure for devices of the highest risk class.

> PROCESS MODELLING – FORGED IMPLANTS

The complete forming sequence can be simulated:

- The initial stage which consists in a 'section reduction' to narrow one side of the metal piece
- The bending stage to curve the metal piece and get the preform
- The forging stages where we can observe how the metal flows in both blocker & finisher stages.

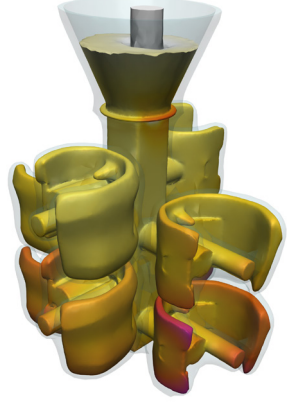


> PROCESS MODELLING – CAST IMPLANTS

THERCAST® software models investment casting with exclusive features:

- Automatic generation of the ceramic shell around the cluster of parts
- Implementation of radiation effect (mode 'surface-to-surface')
- Application of heat transfers between parts during pouring and solidification
- Optimization of the feeder provides a crystalline structure within the alloy

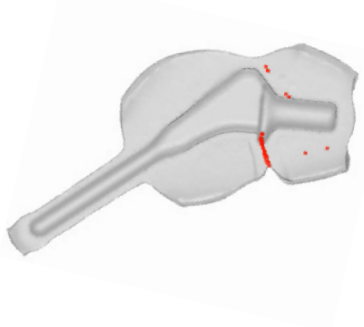
This figure shows knee implants with different temperature gradients at the end of the cycle.

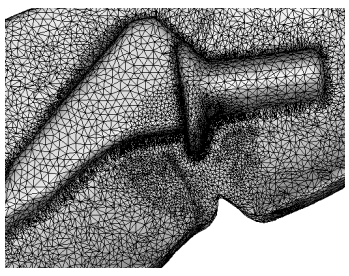


> ADAPTATIVE REMESHING

Thanks to the adaptive remeshing, it possible to:

- Deal with large deformations without losing accuracy
- Reduce numerical noise such as possible oscillations of forging forces
- Detect defects or local phenomena that may take place during the forming, such as folds or cracks.





> SELF-RADIATION IMPACT

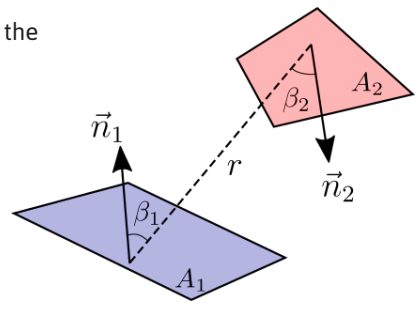
The impact of radiation is essential when simulating investment casting with a pattern cluster.

Two numerical methods have been implemented to compute view factors: the double area summation method and the contour integral method.

The mathematical formulation to calculate the view factor is:

$$F_{12} = \frac{1}{A_1}\int_{A_1}\int_{A_2}\frac{\cos\beta_1\cos\beta_2}{\pi r^2}\,dS_2\,dS_1$$

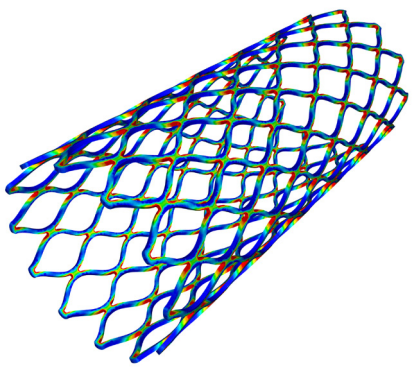
Where the required parameters are depicted in this figure:



> IN-USE PROPERTIES OF MEDICAL DEVICES

Study of the dynamic behavior of a self-expanding stent according to the artery pressure cycle to improve the service life of stents.

- With control of the maximum stress
→ to avoid plastic irreversible deformation
- With correct radial force for the usage diameter
→ to predict the pressure of the stent on the artery

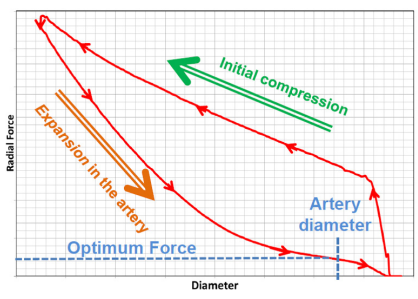


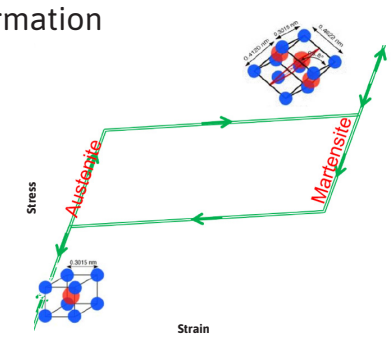
> SHAPE-MEMORY ALLOY

Nitinol is a shape-memory alloy with amazing properties such as pseudo-elasticity. It exhibits a reversible austenitic-martensitic crystalline structure in response to stress and heat.

Nitinol® Behaviour:

- Nickel-Titanium Alloy (≈ 50%-50%)
- Super-elasticity with hysteresis
- Austenite to martensite transformation





> ADVANTAGES OF SIMULATION SOFTWARE

→ **Control your manufacturing processes** and reduce tooling costs

→ **Avoid forging defects** such as folds, underfilling ...

→ **Highlight shrinkage porosities and open-shrinkage defects** created during the solidification and visible on the final part

→ **Simulate the entire forging sequence** including heat treatment

→ **Predict metallurgical properties**

→ **Guarantee the part's fibering**

→ **Predict the grain structure** of the cast parts