# Anisotropy and temperature dependence of superelastic behavior of NiTi shape memory alloy thin walled tubes.

Estephanie Nobre Dantas Grassi[1], Denis Favier[1], Grégory Chagnon[1]

[1] *TIMC-IMAG, University Grenoble Alpes, La Tronche, France*
*E-mail*: *denis.favier@univ-grenoble-alpes.fr*

*Keywords:* NiTi shape memory alloy, Anisotropy, Temperature dependence

Nickel-Titanium (NiTi) alloys are the most successful Shape Memory Alloys (SMA). They have increasingly been used in the form of thin walled tubes for the fabrication of catheters and self-expanding stents. These tubes are manufactured by a series of hot and cold drawing processes which induce a highly texturized microstructure [1, 2]. The presence of texture leads to strong anisotropic mechanical behavior, which has important consequences in the final behavior of devices manufactured from tubes.

This study investigates the anisotropy and the temperature dependence of the superelastic behavior of NiTi thin walled tubes. The anisotropy is experimentally characterized and then analyzed from a thermodynamic point of view [3].

Isothermal superelastic tensile tests were performed at several temperatures above Af on oriented dogbone samples cut in five orientations from the drawing direction. Transformation strains and stresses strongly depend on orientation. Transformation strains are independent of temperature. The temperature dependences of forward and reverse transformation stresses, expressed as forward and reverse Clausius-Clapeyron coefficients, are highly orientation-dependent. The products of the Clausius-Clapeyron coefficients by the transformation strains are not independent of the orientation. All these results are analyzed using the reference frame of equilibrium thermodynamics. The main conclusion is that specific dissipated and stored strain energies during the forward and reverse transformations are dependent on orientation and also on temperature.

*References*

[1] *Poncin, P., Proft, J., "Stent Tubing: Understanding the Desired Attributes", in: Proc. ASM Conf. Mater. Process. Med. Devices, 2003: pp. 253–259.*

[2] *Robertson, S.W., Imbeni, V., Wenk, H.R., Ritchie, R.O., "Crystallographic texture for tube and plate of the superelastic/shape- memory alloy Nitinol used for endovascular stents", J. Biomed. Mater. Res. - Part A. 72, 190–199 (2005).*

[2] *Wollants, P., Roos, J.R., Delaey, L., "Thermally and stress-induced thermoelastic martensitic transformations in the reference frame of equilibrium thermodynamics", Prog. Mater. Sci. 37, 227–288(1993).*