# "In-situ XRD Studies of Shape Memory Ni-Ti Sputtered Thin Films"

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The NiTi system is the most popular of the shape memory alloys (SMA) because of the considerable work per unit mass it can produce during recovery (work output: ~ 1 Joule/g), and because of the value of the transformation temperature (from –100ºC to +100ºC), as well as its good oxidation resistance. The thin films of SMA's can be electrically driven using joule heating, and they demonstrate fast cooling rates because of their large surface-to-volume ratio. The control of film composition and properties has proven difficult in sputter-deposited films, and further study of deposition techniques is needed (1).

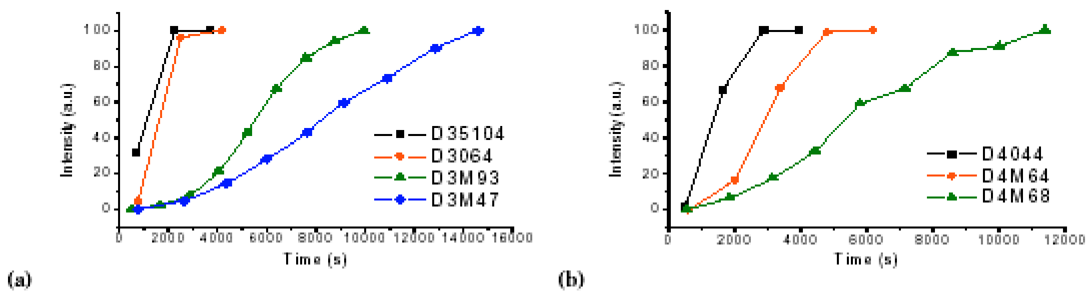
Thin film deposition of Ni-Ti SMA faces two problems:

- when using non-heated substrates, the as-sputtered material is amorphous, thus requiring a further crystallisation heat treatment for the shape memory effect to take place,

- most applications require transition temperatures above room temperature.

Both aspects are strongly dependent on our understanding of the deposition parameters and their influence on the structure build-up during the growth of the films.

At CENIMAT, work has been performed on the optimisation of the sputter deposition techniques, aiming to obtain improved thin films with higher performances (2). A first series of experiments aimed to study the crystallisation kinetics of rf and dc sputtered Ni-Ti thin films on different types of substrates (3-5).




Crystallization kinetics represented by the integrated intensity of the (110) austenite peak versus time (in seconds) during at 430ºC for the distance target/substrate of (a) 70 mm, (b) 40 mm.

Previous studies in similar geometry (6-8) proved the advantage of *in situ* studies to elucidate the texture development and the growth mode of thin films.

This technique has been used for the in situ study of NiTi sputtering. These are the first experimental results reported on the *in situ* analysis of the film growth during sputter deposition of Ni-Ti shape memory alloys (9-12). The sequence of preferential orientations and structural evolution as a function of operating conditions changing will be discussed.

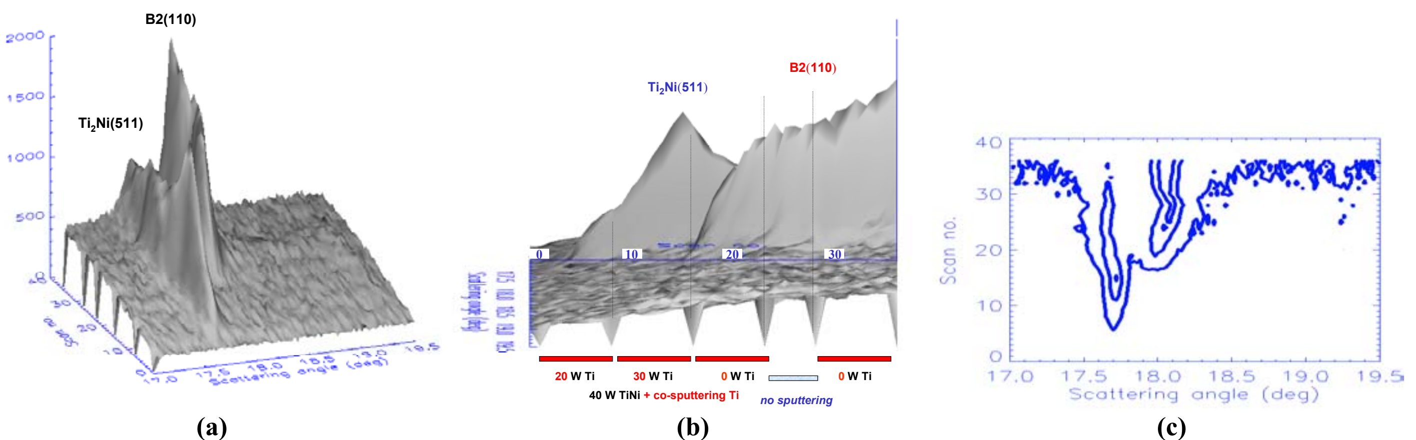



**Fig. 1**: 3D plot of the peak intensity (a, b) and 2D intensity contour level (c) during deposition of sample S19.

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