In-situ **laser ultrasonic measurements of phase transformation kinetics in lean Ti-Mo alloys**

Mariana Rodrigues, Matthias Militzer

The Centre for Metallurgical Process Engineering, The University of British Columbia, Vancouver, Canada.

Molybdenum (Mo) is one of the most common β-stabilizing elements used in commercial titanium alloys. As compared with other conventional β-stabilizers, such as vanadium and chromium, molybdenum possesses the lowest diffusion rate in the β phase[1] and a rather low diffusivity in the α phase[2], thus playing an important role in controlling the rates of diffusional α/β phase transformations. While most of earlier studies focused on complex multicomponent Ti-systems, here we investigate quasi-binary Ti-Mo model alloys with systematically varied Mo content up to 6 wt.% (i.e., the typical content range used in commercial Ti-alloys) to elucidate in detail the effect of Mo on the phase transformation kinetics. Thermodynamics aspects of Ti-Mo systems have been well established, but much less quantitative information is available in terms of kinetics, particularly for lean Ti-Mo alloys. In this study, phase transformations were measured during continuous heat treatments at varying rates using a Gleeble thermo-mechanical simulator coupled with a Laser Ultrasonics for Metallurgy (LUMet) sensor. The measurably different mass densities and elastic constants of the parent and product phases result in variation in the ultrasound longitudinal velocity, which can be correlated to the volume fractions transformed. The transformation kinetics for a given alloy was seen to be more sensitive to cooling rate as compared to heating rate. As expected, increasing the Mo content delays the phase transformations. The results obtained during continuous heating were compared with thermodynamic calculations, while those obtained during cooling were modelled using the additivity concept applied to the Johnson-Mehl-Avrami-Kolmogorov (JMAK) theory. The present study further established laser ultrasonics as a non-contact, *in-situ* and real time characterization technique for phase transformations in Ti-alloys. Thus, laser ultrasonic studies have the potential to significantly contribute to knowledge-based design of optimized Ti-alloys and their heat treatments.

[1] Zhu, L. *et al.* Measurement of interdiffusion and impurity diffusion coefficients in the bcc phase of the Ti-X (X = Cr, Hf, Mo, Nb, V, Zr) binary systems using diffusion multiples. *Journal of Materials Science* **52**, 3255–3268 (2017).

[2] Xu, W. W. *et al.* A first-principles study of the diffusion coefficients of alloying elements in dilute *α*-Ti alloys. *Physical Chemistry Chemical Physics* **18**, 16870–16881 (2016).