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## ABSTRACT:

### Long-Range Ordering in Orthorhombic Ti<sub>2</sub>AlNb Alloys: Effect on Diffusion-Controlled Phase Transformations

Vladimir A. Esin

Université de Lorraine, CNRS, Institut Jean Lamour, Nancy, France.

Orthorhombic Ti<sub>2</sub>AlNb alloys are an emerging class of lightweight metallic materials, offering superior oxidation resistance and ductility compared to conventional Ti alloys and  $\gamma$ -TiAl intermetallics, respectively [1]. Their properties stem from a carefully engineered three-phase microstructure comprising a cubic  $\beta$ -matrix, orthorhombic O-phase and hexagonal  $\alpha_2$ -phase. Unlike most industrial alloys (steels, Ni-/Al-/Ti-based systems), the high-temperature  $\beta$ -phase in Ti<sub>2</sub>AlNb alloys can exist in both ordered and disordered states, depending on the Al/Nb ratio [2]. For two decades, the ordering behaviour of this phase has remained debated due to qualitative assessments (using TEM or conventional XRD).

Here, we employ in situ synchrotron high-energy XRD to quantitatively determine the degree of long-range order in the  $\beta$ -phase during cooling from the  $\beta$  single-phase domain. We reveal a composition-driven disordering effect induced by diffusion-controlled O-phase precipitation, which alters the local Al/Nb ratio [3]. The correlation between  $\beta$ -phase long-range order and the kinetics of diffusion-controlled transformations (e.g.,  $\beta \rightarrow O$ ) is discussed. Results highlight a non-monotonic dependence of long-range order on Al/Nb content, identifying a critical compositional range where  $\beta$ -phase ordering can be suppressed. These insights provide a foundation for designing next-generation orthorhombic alloys with tailored phase stability.

[1] D. Banerjee et al., *Acta Metall.* 36, 871 (1988).

[2] C.J. Boehlert et al., *Metall. Mater. Trans. A* 30, 2305 (1999).

[3] V.A. Esin et al., *Mater. Character.* 169, 110654 (2020).