

## **CSC-RUB PhD Project Proposal**

Title: Atomic-scale insights into the role of oxygen in the phase formation in metastable  $\beta$ -Ti alloys

Sector of research: Materials Science/Physical Metallurgy

Degree awarded: PhD

Keywords: Materials Characterization, atom probe tomography, transmission electron microscope, titanium alloys, phase transformation

Supervisor of PhD project: Prof. Dr. Tong Li, e-mail: tong.li@rub.de

Research focus of supervisor:

My research focus is to utilize high-end materials characterisation techniques including atom probe tomography and transmission electron microscopy to study structure and chemistry at surfaces, interfaces or in phases of catalyst materials and high-strength alloys. The aim is to establish relationships between synthesis (or processing), structure and performance, thereby providing new insights into materials design. I have led various cross-disciplinary projects which have led to ~50 important publications (H index: 23) in high-quality refereed journals such as Science, Acta Materialia and Scripta Materialia. My current research interests are: 1) phase transformation in Ti alloys/high entropy alloys, 2) spinel/perovskite nanoparticle synthesis and 3) high-end characterisation and electrochemical measurements of oxide nanoparticles for water splitting.

## **Publications:**

(1) A. BalaKrishnan, N. Blanc, U. Hagemann, P. Gemagami, K. Wonner, K. Tschulik, **T. Li**, *Direct detection of surface species formed on iridium electrocatalysts during the oxygen evolution reaction*, Angewandte Chemie International Edition (2021) doi: 10.1002/anie.202106790

(2) M.J. Lai, **T. Li**, F.K. Yan, J.S. Li, D. Raabe, *Revisiting*  $\omega$  *phase embrittlement in metastable*  $\beta$  *titanium alloys: Role of elemental partitioning*, Scripta Materialia (2021), 193, 38-42

(3) Z. Ji, **T. Li**\*, OM. Yaghi\*, *Sequencing of metals in multivariate metal-organic frameworks*, Science (2020), 369 (6504), 674-680 (\*corresponding author)

(4) **T. Li**, M. Lai, A. Kostka, S. Salomon, S.Y. Zhang, C. Somsen, MS. Dargusch, D. Kent, *Composition of the nanosized orthorhombic O' phase and its direct transformation to fine*  $\alpha$  *during ageing in metastable*  $\beta$ *-Ti alloys*, Scripta Materialia (2019), 170, 183-188

(5) **T. Li**, O. Kasian, S. Cherevko, S. Zhang, S. Geiger, C. Scheu, P. Felfer, D. Raabe, B. Gault, and K. Johann Jakob Mayrhofer. *Atomic-scale insights into surface species of electrocatalysts in three dimensions*. Nature Catalysis (2018), 1, no. 4: 300-305.



## Summary of research plan (ca. 300 words):

Background:  $\beta$ -Ti alloys are an excellent choice for many aerospace and biomedical applications due to their high specific strength, superior toughness and good corrosion resistance. Metastable phases play a crucial role in determining the microstructure of  $\beta$ -Ti alloys after thermomechanical treatment and, therefore, influence their mechanical properties. A new nanosized metastable phase, termed O', was recently found in the matrix of Ti–Nb-based alloys after quenching. The inclusion of the O' phase in studies of deformation behaviour potentially offers the exciting promise of a deeper understanding of the much-disputed mechanisms behind the superelasticity exhibited by Ti–Nb-based alloys. However, the precise nature of the formation of the O' phase is currently poorly understood. Interstitial oxygen atoms are thought to promote O' phase formation, but experimental evidence is not yet available.

**Study objective:** The aim is to improve the understanding of the effect of oxygen on the formation of the newly discovered O' phase, as well as to establish the relationship between microstructure and mechanical properties.

**Expected Results:** The novel mechanistic insights that will be obtained in this project will not only advance the knowledge base into the field of physical metallurgy in Ti alloys but will also lead to new approaches in the design of microstructure for both aerospace and shape-memory-related applications.

Methods: atom probe tomography and transformation electron microscopy

## **Candidate Requirements:**

- an excellent master's degree in materials science
- solid knowledge of physical metallurgy, familiar with phase transformation in titanium alloys or deformation in BCC titanium alloys
- a high level of spoken and written English (IELTS band score of 6.5 or higher)

Motivation for CSC application: The successful candidate will be working in the new research centre for interface-dominated high-performance materials (ZGH) at Ruhr University Bochum, which houses a large and comprehensive suite of equipment dedicated to nanostructure analysis; the centre is among the best facilities of its kind in the world. She or he will have access to a world-class set of laboratories and more than five major microscopy platforms, including the state-of-the-art atom probe, aberration-corrected TEM and focused ion beam. My research group collaborates intensely with international universities and research institutes such as Tsinghua University, University of Oxford and University of Sydney etc. We aim to provide students with an international and interdisciplinary platform to conduct high-level scientific research.