MM 35: Additive Manufacturing / Transport in Materials III

Time: Thursday 15:45–17:30 Location: SCH/A216

MM 35.1 Thu 15:45 SCH/A216

Tailoring Microstructure and Mechanical Properties of LPBF Ti-5553 Alloy by STA Heat Treatment — •Yang Lei[1,2], Parthiban Ramasamy[2], and Jürgen Eckert[1,2] — [1]Department of Materials Science, Chair of Materials Physics, Montanuniversität Leoben, Jahnstraße 12, A-8700 Leoben, Austria — [2]Erich Schmid Institute of Materials Science, Austrian Academy of Sciences, Jahnstraße 12, A-8700 Leoben, Austria

Ti-5553 is a metastable β titanium alloy widely used in aerospace gears due to its exceptional strength, toughness, and hardenability. However, Laser Powder Bed Fusion (LPBF) fabrication introduces significant limitations, particularly strong anisotropy and persistent columnar grains.

Solution Treatment and Aging (STA) offers a critical pathway to tailor these properties. This study investigates the microstructural evolution during STA, revealing a competition between nucleation driving force and diffusion kinetics that dictates the initial α-phase morphology. Notably, the columnar β grain size was restricted after heat treatment due to Zener pinning effect exerted by α precipitates, which impedes boundary migration and suppresses recrystallization.

Consequently, the specific microstructural features formed during solution treatment significantly influence subsequent aging behavior. Since β-grain refinement is inhibited, the enhancement in tensile strength is attributed primarily to Orowan strengthening via dispersed precipitates rather than Hall-Petch strengthening.

MM 35.2 Thu 16:00 SCH/A216

Electron Microscopy Investigation of AM316L before and after Heat Treatment: Implications for Hydrogen Diffusion — •Gabriele Palazzo[1,2,3], Kai Stefan Lagemann[1], Svetlana Korneychuk[1,2,3], Stefan Wagner[1], Christian Kübel[2,3], and Astrid Pundt[1] — [1]Institute for Applied Materials, Karlsruhe Institute of Technology, Karlsruhe, Germany — [2]Institute of Nanotechnology, Karlsruhe Institute of Technology, Karlsruhe, Germany — [3]Karlsruhe Nano Micro Facility, Karlsruhe, Germany

As hydrogen technologies evolve, understanding local hydrogen-metal interactions in structural alloys becomes critical. High-pressure hydrogen storage requires materials resistant to hydrogen embrittlement (HE). Austenitic stainless steels are promising, and selective laser melting (SLM) enables attractive properties but can reduce resistance to hydrogen environmental embrittlement (HEE). We investigate additively manufactured 316L (AM316L) steel and its interaction with dissolved hydrogen, focusing on microstructure evolution under directed heat treatments. SEM and (S)TEM with STEM-EELS/EDX map elemental distributions, while EBSD and STEM-ACOM resolve grain structure and sub-grain dislocation cells (SDC). Comparing as-built and heat-treated states by ex-situ TEM and hydrogen diffusion measurements, we show that heat treatment alters the microstructure, reduces hydrogen diffusivity, and lowers HEE susceptibility [1]. [1] Kai Stefan Lagemann, Gabriele Palazzo, Tim Lucas Haag, Svetlana Korneychuk, Stefan Wagner, Christian Kübel, and Astrid Pundt. Manuscript submitted. 2026.

MM 35.3 Thu 16:15 SCH/A216

Diffusion processes in magnetron sputtered copper-gold thin films: layer design, argon pressure tuning and Kirkendall effect — •Oliver Wipf and Ralph Spolenak — Departement of Materials, ETH Zürich, Vladimir-Prelog-Weg 1-5/10, 8093 Zürich, Switzerland

Controlled Kirkendall voiding is a promising diffusion process to fabricate hollow nano- and micro-structures. This work extends the understanding and use of the Kirkendall effect as a route to fabricate voids in magnetron sputtered copper-gold thin films, a process with a high degree of control over the deposited thin films and a pathway to scalable, novel applications of diffusion self-organized thin film technology. To study the diffusion in the thin films, double and triple layered samples were fabricated using low and high argon gas pressures during the deposition. Annealing of the samples resulted in large voids located at the wafer to film interface and in the center of the film, depending on the layer structure. Using a comprehensive diffusion study, we demonstrate that diffusion in copper-gold thin film diffusion couples is dominated by vacancies moving, which leads to the growth of Kirkendall voids.

MM 35.4 Thu 16:30 SCH/A216

Visualizing lithium dynamics in battery electrodes by operando optical microscopy — •Monica Mead[1], Shihao Wei[1], Vidula Amburе[1], Nadine Kerner[1], Roham Talei[1], Yug Joshi[2], and Guido Schmitz[1] — [1]Max Planck-Institut für nachhaltige Materialien GmbH, Max-Planck-Straße 1, 40237 Düsseldorf — [2]Universität Stuttgart, Heisenbergstraße 3, 70569 Stuttgart

Typically, chemical diffusion coefficients of Li-ions in battery electrodes are measured by purely electrochemical methods such as potentiostatic or galvanostatic intermittent titration technique (GITT/PITT), cyclic voltammetry (CV) or electrochemical impedance spectroscopy (EIS). Surprisingly, the correspondingly determined diffusion coefficients vary within up to ten orders of magnitude. This cannot be explained solely by the influence of concentration dependence and microstructure. To clarify the origin and thereby understand which additional factors influence the ion transport, alternative methods have to be developed and applied. Therefore, we apply a method based on optical microscopy and the optical response upon Li intercalation in different Li-ion battery electrodes, such as lithium manganese oxide, lithium titanate, vanadium oxide and silicon. With this method, the transport along several hundreds of micrometres can be measured, which allows differentiation between different transport mechanisms (diffusion/transport across a kinetic barrier). We find that above-mentioned electrochemical methods tend to underestimate the diffusion coefficient. We discuss the origin with respect to the transport mechanism.

MM 35.5 Thu 16:45 SCH/A216

Kinetic analysis of lithium transport in silicon anode using operando optical microscopy — •Shihao Wei[1], Monica Mead[1], Yug Joshi[2], and Guido Schmitz[1] — [1]Heisenbergstraße 3, 70569, Stuttgart, Germany — [2]Max-Planck-Straße 1, 40237, Düsseldorf, Germany

Understanding lithium diffusion and phase transformation in silicon(Si) anodes is essential for the advancement of high-capacity lithium(Li)-ion batteries. In this work, Li transport behavior and phase evolution are investigated using an in-situ optical method, which enables direct visualization of phase movement and measure Li migration across phase boundaries, advantages not offered by conventional techniques, such as EIS, SIMS, and NMR. First, it is observed that the lithiation process on a semi-infinite plane is predominantly governed by diffusion-controlled parabolic growth, with minimal evidence of interface-controlled linear growth. The temperature dependence of transport is explored, quantified with an Arrhenius-like model, revealing the activation energy of diffusion and interfacial reaction. In contrast, delithiation exhibits markedly sluggish kinetics and behaves fundamentally differently. To investigate this behavior, smaller circular geometries with limited diffusion depth creating a 2D transport scenario are examined. In these confined structures, lithiation is demonstrated by a Deal-Grove-type model. Remarkably, during delithiation, instead of a distinct moving interface, the lithiated phase gradually fades as lithium ions leave. Such a difference implies that lithiation and delithiation follow distinct reaction pathways.

MM 35.6 Thu 17:00 SCH/A216

W diffusion in Mo-Ta alloys: temperature dependence and vacancy energetics — •Aditya Burla[1], Xiang Xu[2], Felix Kipke[1], Hartmut Bracht[1], Xi Zhang[2], Blazej Grabowski[2], Gerhard Wilde[1], and Sergiy V Divinski[1] — [1]Institut für Materialphysik, Universität Münster, 48149 Münster, Germany — [2]Institut für Materialwissenschaft, Universität Stuttgart, 70569 Stuttgart, Germany

Refractory metals and their alloys have gained renewed attention with the emergence of high-entropy alloy concepts, driven by their exceptional properties at elevated temperatures. However, despite their technological significance, diffusion data for refractory binary systems remain sparse, limiting predictive understanding of defect-mediated transport at high temperatures. This study addresses this gap by investigating tungsten diffusion in the binary Mo-Ta system. Diffusion profiles were measured using secondary ion mass spectrometry after annealing in the temperature range of 1373K to 2273K. A key focus

is on correlating the diffusion behavior with the vacancy formation energies. Complementary computational analysis provides atomistic insights, revealing composition-dependent variations in vacancy energetics within the Mo-Ta system. Its influence on W diffusivity and activation energies is discussed. This combined approach provides a comprehensive framework for understanding W diffusion and vacancy-controlled transport in Mo-Ta alloys, offering valuable guidance for the design of advanced refractory materials.

MM 35.7 Thu 17:15 SCH/A216

Hydrogen Diffusion in ß-MoO_3 Thin Films Governed by Structural Changes — •Tim K. Hecker, Martin Becker, and Peter J. Klar — Institute of Experimental Physics I and Center for Materials Research, Justus Liebig University Giessen, Giessen, Germany

Hydrogen incorporation strongly alters the electronic, optical and structural properties of transition-metal oxides. In MoO_3, hydrogen intercalation forms H_xMoO_3 bronzes that exhibit reversible color changes, lattice distortions and notably higher hydrogen diffusion coefficients. Although these effects are central to electrochromic, catalytic, sensing and energy storage applications, the mechanisms of hydrogen transport remain poorly understood, especially in the metastable ß-phase. To address this, we performed electrochemical hydrogen insertion into ß-MoO_3 thin films covered by a PMMA layer, only allowing incorporation in a small, well-defined uncovered stripe. Hydrogen only enters through this gap and then diffuses laterally beneath the PMMA in a semi-infinite space. Using the electrochromic response of MoO_3 in combination with the Beer-Lambert law, we monitored the hydrogen concentration in-situ. These diffusion profiles were then analyzed with a deep-learning algorithm to extract concentration dependent diffusion coefficients. We identify two distinct increases in the diffusion coefficient as hydrogen concentration rises. Complementary Raman measurements during intercalation and deintercalation link these changes to partial structural transformations, each increasing the hydrogen diffusion coefficient by nearly one order of magnitude.