Karlsruher Institut für Technologie

Laboratorium für Elektronenmikroskopie

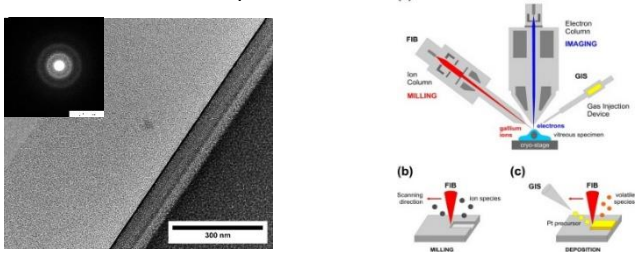
Masterthesis

TEM Investigation of Multilayer Sample for High Temperature Application

Motivation

The higher operating temperature has a powerful effect on the performance of, for example, gas turbine engines. The higher the temperature, the higher the efficiency. The current materials used in internal combustion engines are made of Ni-based superalloys. However, this material has reached the critical limit of operating temperature (T=1100°C), as they already operate at about 80% of their homologous temperature. We need a new material system to withstand even higher operating temperatures (T>1300°C). A promising material system for this application is for example eutectic Mo-Si-Ti alloy coated with polymer derived ceramic nanocomposites (PDC-NCs) based on Si(M)CX where M=B, Zr, Hf and X=O, N.

In order to allow for potential design of novel material compounds based on the integration of different composite materials, apart from optimized synthesis routes and annealing techniques to achieve for example crack-free full density and/or graded structures, it is essential to characterize in detail the microstructural evolution at the interfaces. Therefore, state-of-the-art electron microscopy (EM) techniques (such as SEM, HRTEM and STEM) studies are applied to various composite materials throughout the project. It is anticipated to gain a detailed understanding of the microstructural changes that are induced via e.g., thermal annealing in different atmosphere and how those changes affect material's response at elevated temperature.



TEM image of Si substrate coated with PDC-NC (left), FIB deposition and milling process (right)

Tasks

- Familiarization with electron microscope (SEM, TEM) and FIB (Focus Ion Beam) sample preparation technique
- Microstructural characterization (interface structure or local nanocrystalline precipitates) at the interfaces
- Chemical characterization (segregation, local enrichment of specific elements) at the interfaces

Timeline

- 1st-2nd month: literature review and sample preparation using FIB
- 3rd-5th month: TEM introduction and performing TEM investigation at the interfaces
- 6th-7th month: analyzing results and thesis writing

Research area:
Microstructural and chemical characterization, high temperature materials

What you will learn:
Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Focused Ion Beam (FIB)

What you bring:
Master student in materials science or physics, basic knowledge in materialscience and high temperature materilas

Starting date:
Beginning of 2025

Language:
English or German

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