# HIGH-RESOLUTION STRUCTURAL-MECHANICAL CHARACTERIZATION AND SIMULATION OF NOVEL BARRIER COATINGS

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Ceramic matrix composites and non-oxide ceramics are potential near-future materials for high temperature applications in gas turbines for energy production and aviation. Mechanical strength and the capability to withstand temperatures up to 1500 °C under load make these ceramic materials perfect candidates to increase efficiency and to lower emissions. However, corrosive attack by water vapor is still a reliability- and lifetime-limiting factor. Also, thermal insulation is important for oxide ceramic matrix composites because of their low temperature limit in comparison to non-oxide ceramics, e.g. silicon nitride. Therefore, protective coatings are a substantial component in such advanced applications.

A new type of coating is investigated which shall act as an environmental and thermal barrier. As a novel approach, a single phase material with high corrosion resistance and low thermal conductivity will be deposited. Solid-state reactions between the substrate material and the coating should provide strong adhesion. In addition, a defined pore distribution should provide good thermal insulation and high tolerance against defects. As a result, a novel, superior coating system is supposed to be achieved for the industrial applications mentioned above.

The development of new material systems and coatings requires extensive studies of structure-property relationships and knowledge about the material behavior in dependence on its structure. As a new approach, 3D reconstruction methods will be used to describe the material, using non-destructive micro-X-ray computed tomography and scanning electron microscopy combined with cross-sectioning using a focused ion beam. Especially the non-destructive X-ray technique has the distinct advantage of performing corrosion testing and studying several stages of the evaluation of weak spots in the material-coating system. On the other hand, electron microscopy allows to create 3D images of pores or cracks down to 1 nm resolution in order to improve the understanding of their formation and evolution. Both techniques are well-suited to quantify important structural parameters such as the pore size distribution and pore topology, which can hardly be measured with other methods. The structural information is supplemented by extensive multi-scale mechanical property studies using nano- and microindentation covering the scales from the nano- to the micro-range. To link the multi-scale structural to the multi-scale mechanical material information, both are combined in finite element simulations. With these simulations, the relations between the macroscopic barrier coating properties and the microscopic coating structure will be studied.