MASTER THESIS:
Ultra-thin metallic films on functional ceramics - Catalysis and Growth

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I. INTRODUCTION

Agglomerated Pt thin films have been proposed as electrodes for electrochemical devices like micro-solid oxide fuel cells (μ-SOFCs) operating at low temperatures. However, comprehensive studies elucidating the interplay between agglomeration state and electrochemical properties are rare.
Recently it has been shown that, it is rather the nanostructure involving grain boundaries, triple lines, grooves and voids, which determines the catalytical properties of such thin metal films on functional ceramics than the geometric boundaries of the film [1]. Hence, intelligent tailoring of the nanostructure of metal electrodes will be the key to superior electrode performances in the future. However, the reduction of grain and feature sizes might impair the thermal stability of highly active metallic thin film electrodes.

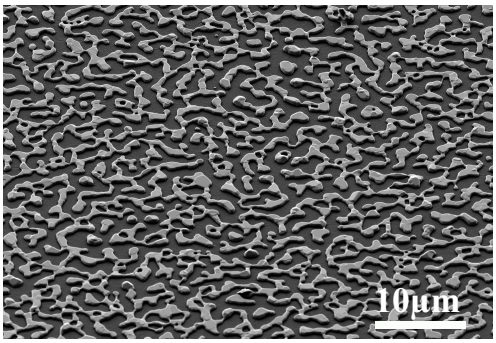

FIG. 1. SEM image of an agglomerated Pt-thin film on Si_3N_4 after annealing at 1023 K

II. AIM

In order to provide for a constant performance, μ-SOFC electrodes have to be stable at operation conditions $400 - 600°$ C. In this regard it deems necessary to understand the kinetics of growth that lead to the complex and stable morphologies needed for a SOFC electrodes. Furthermore the transport paths of oxygen through the thin metal layer will be analyzed.

III. APPROACH

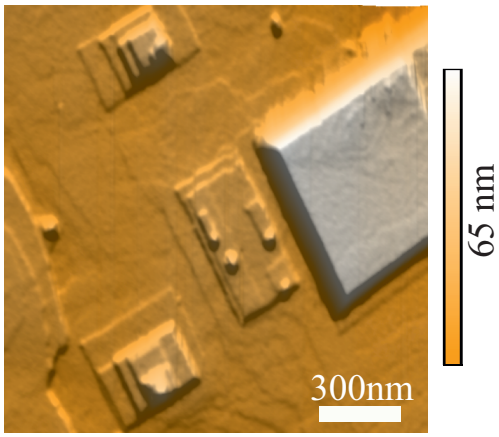

FIG. 2. AFM image of an PtFe-thin film on YSZ indicating 2D-3D growth transition

Thin metal films and thin multilayer systems are going to be deposited by Pulsed Laser Deposition (PLD). For microstructural analysis SEM image analysis, AFM, Rutherford Backscattering Spectroscopy (RBS) and atom probe tomography are available. The results will be compared with the existing models for grain boundary segregation and the growth kinetics of thin metal films deposited via PLD. Information concerning the electrochemical performance of patterned thin films will be obtained by conductivity measurements and Electrical Impedance Spectroscopy. Experimental results will be compared to kinetic Monte Carlo (KMC) simulations.

IV. CONTACT

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[1] T. Ryll, H. Galinski, L. Schlagenhauf, P. Elser, J. L. M. Rupp, A. Bieberle-Hutter, and L. J. Gauckler, Advanced Functional Materials **21**, 565 (2011).