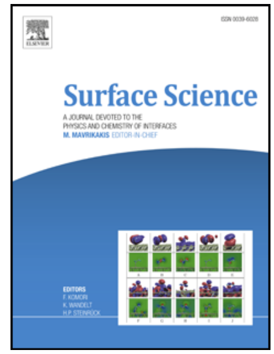

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Preparation of Silica Films on Ru(0001): A LEEM/PEEM Study

H.W. Klemm, G. Peschel, E. Madej, A. Fuhrich, M. Timm, D. Menzel, Th. Schmidt, H.-J. Freund

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Preparation of Silica Films on Ru(0001): a LEEM/PEEM Study

H.W. Klemm, G. Peschel, E. Madej, A. Fuhrich, M. Timm, D. Menzel, Th. Schmidt, and H.-J. Freund

Department of Chemical Physics, Fritz-Haber-Institute of the Max-Planck Society, Faradayweg 4-6, 14195 Berlin, Germany

Abstract

We use an aberration corrected spectro-microscope, the low energy electron microscope/photoelectron emission microscope (LEEM/PEEM) SMART, to follow the preparation and structure of a bilayer silica film on Ru(0001) as function of temperature and oxidation conditions. This allows us to analyze the growth process at different length scales in order to judge on the overall quality and the morphology of the film. It is found that the film growth occurs in a crystalline and a vitreous phase as previously discovered using scanning tunneling microscopy. However, the present experiment allows an analysis on the sub-micron level to gain insight into the growth process at a mesoscopic scale. We find that the fully oxidized film can be prepared but that this film contains holes. These are unavoidable and are important to consider, if one wants to use the films for ensemble averaging experiments to investigate migration and reaction of molecules between the silica film and the Ru(0001) substrate.

Keywords: silica, oxide films, growth, LEEM, XPEEM, LEED, XPS

1. Introduction

The most abundant minerals on the earth's crust are silicates. The mother compound, of course, is quartz and it comes as crystalline and vitreous or glassy phases.[1] The discovery of the details of the vitreous-crystal transition is still to come, and we and collaborators have recently made a step towards unraveling the structure of both, the crystalline as well as the vitreous phase in real space by scanning tunneling (STM) and atomic force microscopy (AFM) of a bilayer silica film grown on Ru(0001) as shown in Fig.1.[2-13] One can clearly identify the silica ring structure composed of SiO_4-tetraedra connected into a hexagonal network of rings in the crystalline phase, while in the vitreous phase the connectivity changes and allows for larger and smaller ring systems, as predicted 80 years ago by Zachariasen.[14] After our discovery similar films have been prepared and characterized on graphene [15, 16], Pd (100) [17] and Pt(111) [18] using STM and transmission electron microscopy. However, those characterization techniques usually do not allow a sufficiently wide scanning range so that conclusions can only be drawn on small areas of silica covered Ru surfaces. On the other hand, if one is interested in properties of such systems, which have to be investigated using ensemble-averaging techniques, this requires information on at least a mesoscopic length scale in order to draw representative conclusions. For example, we are interested in the investigation of diffusion of molecules of different sizes through the silica film in order to study chemistry in constrained space, a topic that came up first with zeolites [19], but has now been