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Preface

Engineering of Functional Surfaces and Interfaces

Dear colleagues,

On the following pages you will find a topical section with a series of 21 selected articles covering recent trends in the "Engineering of Functional Surfaces and Interfaces". This seminal domain is at the touching point between classical solid-state physics and the tremendously growing field of nanotechnology. Actually, surface physics was somehow hampered because classical concepts such as the electronic band structure and the phonon description of solids cannot be transferred easily to surfaces where the concepts of periodic boundary conditions and translational invariance naturally fail. The Austrian physicist and Nobel-laureate Wolfgang Pauli had summarized this in the well-known proverb *"Das Volumen des Festkörpers wurde von Gott geschaffen, seine Oberfläche aber wurde vom Teufel gemacht"*. Freely translated, this means that 'surfaces are the work of the devil, a domain where researchers should better stay off'. Nowadays however, a rich variety of surface- and interface-related phenomena is well established, including e.g. band-bending effects, peculiar magnetic-ordering states, quasi particles, surface reconstructions, heterogeneous catalysis, and dangling bonds, allowing for the chemical functionalization of surfaces with ligands.

The theoretical understanding of these effects has considerably grown during the past years while there are still major challenges when modeling the properties of heterosystems with two or more dissimilar materials interacting at the nanoscopic scale. At the same time, there have also been considerable improvements in analytical instrumentation, allowing studying the electronic, vibronic, and chemical properties down to the scale of individual atoms. A prominent role in this plays the wide and growing variety of scanning-probe techniques while also the 'macroscopic probes' such as optical spectroscopy gain higher and higher lateral resolution. In parallel to the increasing performance of analytical devices, also more and better tools become available allowing to modify surfaces with respect to morphology and chemical composition in a targeted fashion. This way, surfaces and interfaces acquire additional functionalities that are impossible to achieve with a bulk material alone. Application areas of these engineered 'smart' surfaces cover a wide range of fields: One may think of catalysts, anticorrosive and self-cleaning coatings in the context of chemistry, issues of biocompatibility and healing in the domain of medical implants, and physical, chemical, and biological sensors utilized for a diversity of analytical tasks.

The first section of this topical issue focuses on the preparation of nanostructures, heterostructures, and thin films based on metals and their alloys, semiconductors, oxides, hydrogels, and biological layers. The second section is devoted to novel analytical techniques for the study and characterization of functional surfaces and interfaces, highlighting especially non-destructive optical and electrochemical concepts. The integration of functional surfaces in sensor devices is addressed within the third section, providing examples from the fields of gas sensors,

chemo- and biosensors. An especially important aspect here is the implementation of functional interfaces in complex analytical systems, in which sensitive layers play a crucial and enabling role.

Concluding, we believe that this topical section gives an up-to-date cross section of various important facets of functional interfaces, ranging from fundamental aspects of surface physics to the broad impact on device engineering, chemistry, and the life sciences.

Guest editors:
Achim Walter Hassel, Johannes-Kepler University Linz, Austria
Patrick Wagner, Hasselt University, Belgium
Michael J. Schöning, Aachen University of Applied Sciences, Germany