Preface

SURFACE LAYERS;
a playground for scientists and engineers

For the mechanical engineer, the surface of a workpiece is the location where the constitutive material is most vulnerable to action from the environment. For example, fatigue damage is often initiated at the surface, wear occurs at the surface and corrosive agents attack the surface. Improvement of only the properties of the surface can largely improve the performance of the entire workpiece. Hence, engineering the surface by the application of surface layers has become of major importance. Two, principally different routes can be followed to obtain a surface layer: (i) treating the surface of the original material or (ii) covering the surface with another material. Examples of the first route are laser/electron beam hardening, thermochemical treatments like carburising and nitriding and plasma treatments. The surface layers resulting from such processes can be characterised as relatively thick layers, with a thickness ranging from 5 to 50 µm. Examples of the second route are chemical and physical vapour deposition (CVD and PVD), thermal spraying and cladding. The surface layers resulting from these processes can be relatively thin, up to 5 µm for CVD and PVD as well as very thick, about 100 µm or more as for thermal spraying and cladding.

For the electronic engineer, the surface of silicon is the playground for designing intricate networks of miniaturised highways and bridges for electrons to form integrated circuits. The engineering of chips would have been completely impossible without the emergence of the science and technology of thin films, with thicknesses smaller than 1 µm.

For the chemist, the surface of an arbitrary substrate or a specific catalyst is the place of action for reacting components. This is in particular highlighted by the research on gas-solid interactions (see Chapter III and IV of these proceedings) and the synthesis of surface layers of, for example, ceramic wear-resistant coatings, high-Tc superconducting coatings and diamond coatings (see Chapter I).

For the physicist, the surface causes aberrations from elegant theories proposed to describe the behaviour of infinite bodies. The emergence of “mesoscopic physics” to understand such “aberrations” is strongly stimulated by the continuing miniaturisation in IC-technology. Thin surface layers enable the solid state physicist to investigate the...
interrelated behaviour of solid state diffusion, phase transformations and the development and relaxation of stress. Particularly suitable for this purpose can be specimens containing a multitude of interfaces as in periodic multilayers (see Chapter II of these proceedings). Analysis of surface processes requires special characterization methods. Usually these are based on physical phenomena. (A few of these are discussed in Chapter V of these proceedings).

For the materials scientist and engineer, surface layers provide a playground for an exemplary interaction of science and technology. By studying the relation between manufacturing conditions and the microstructure of the resulting surface layers as well as the relation between the microstructure and the resulting properties, they are able to tailor surface layers with the optimum microstructure that provides the properties required for a certain application. As a matter of fact the research of surface layers characterizes the essence of materials science.

For the "Delft scientist" 1992 was a special year. The Delft University of Technology celebrated its 150th anniversary. Three research groups of the Delft Institute for Materials Science and one of the Interfaculty Reactor Institute participated in the organisation of a two-day symposium entitled "Surface Layers: Structure-Property Relations". The symposium was subdivided into four sessions. In each session different aspects of surface layers were treated by two distinguished scientists from abroad and one or two Dutch scientists. These proceedings are composed of the carefully prepared contributions of nearly all presentations. By no means it has been the intention to cover all applications of surface layers or to provide a complete overview of the types of surface layers. Instead, it has been our purpose to present an illuminating view on several aspects of synthesis, properties and characterisation of some interesting and important types of surface layers. The emphasis has been on the science rather than on the engineering.

We hope that these proceedings are useful and provide a stimulus for further research.

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