

PROTEIN ADSORPTION ON OXIDE PARTICLES: NEW INSIGHTS WITH COLLOID CHEMISTRY METHODS AND APPLICATION

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INTRODUCTION: Most metallic biomaterials are covered by a protective, stable oxide film such as titanium oxide on titanium. Hence proteins only interact with the oxide film and not with the underlying metal. Closer investigations of the protein - oxide interface are therefore of great relevance to the biomaterials field.

In the past few years protein adsorption and desorption has been investigated mostly on planar surfaces by in situ techniques such as Ellipsometry, Optical Waveguide Light Mode Spectroscopy (OWLS) and Quartz Crystal Microbalance (QCM).

The main drawback of these methods is the lack of direct information about Surface Charges, which are known to strongly affect protein adhesion and conformation at interfaces. By applying colloid chemistry methods, e.g. Electrokinetic Measurements, supplementary data was obtained about surface charges, protein layer thicknesses and enzyme activity of particle – protein systems.

In addition, colloidal particles provide a very high specific surface area for applications such as Biosensors (see Fig. 1), where enhanced chemical activity is crucial. Furthermore we think that the presented methods and results are essential to the rapidly growing field of Colloidal Patterning.

were determined with great precision and across a wide pH range.

RESULTS: Adsorption of Bovine Serum Albumin was found to alter the Zetapotential of the Oxides and their Isoelectric Points to an extent depending on the mass of the adsorbed protein. Combining UVS and XDC, the volume density and the thickness of the protein layer was determined.

DISCUSSION & CONCLUSIONS: We have shown that simple colloid chemistry methods give a variety of information about particle – protein systems in a very straightforward manner.

Adsorption of Bovine Serum Albumin was found to alter the Zetapotential of the Oxides and their Isoelectric Points to an extent depending on the mass of the adsorbed protein. Combining UVS and XDC, the volume density and the thickness of the protein layer was determined. It was found that adsorption on Al_2O_3 particles occurs only in the “end-on” mode, whereas on SiO_2 particles BSA adsorbs first in the “side-on” mode and then, only at higher amounts ($> 200 \text{ ng/cm}^2$), in the “end-on” mode. UVS and XDC measurements showed negligible protein adsorption for TiO_2 particles. In contrast, CVP measurements demonstrated an IEP shift to the protein’s IEP of pH 5. We think that the protein was stripped off during centrifugation. This hypothesis is the object of our present research.

REFERENCE: ¹Martin Heule, K. Rezwan, L. Cavalli, L. J. Gauckler, Miniaturised enzyme reactor based on hierarchically shaped porous ceramic microstruts in *Advanced Materials*, accepted 2003.

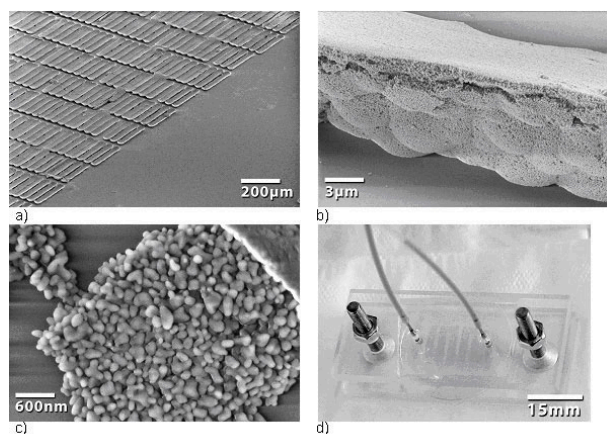


Fig. 1: Miniaturised enzyme reactor based on hierarchically shaped porous ceramic microstruts. [1]

METHODS: For the first time, we used colloid chemistry analysis methods such as colloidal vibration potential (CVP), X - ray disc centrifuge (XDC) measurements and UV – spectroscopy (UVS) to study in detail the adsorption of proteins to well-defined colloidal particles of typically 100 - 300 nm diameter. Combining these methods, the adsorbed amount of proteins and its influence on the zetapotential and the isoelectric point of the particles