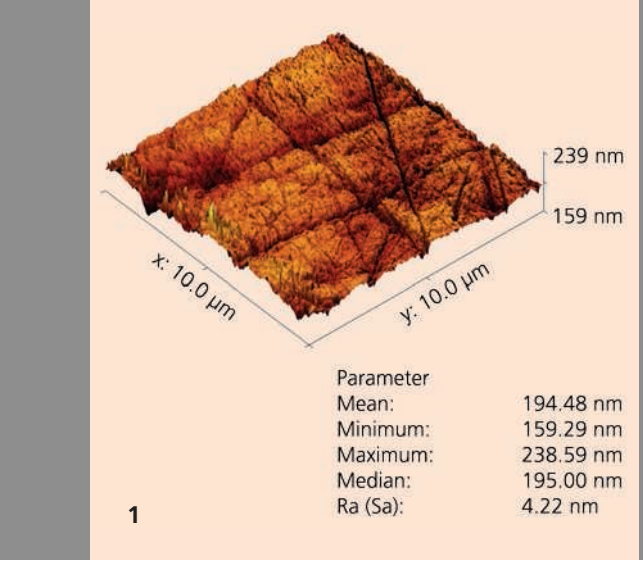

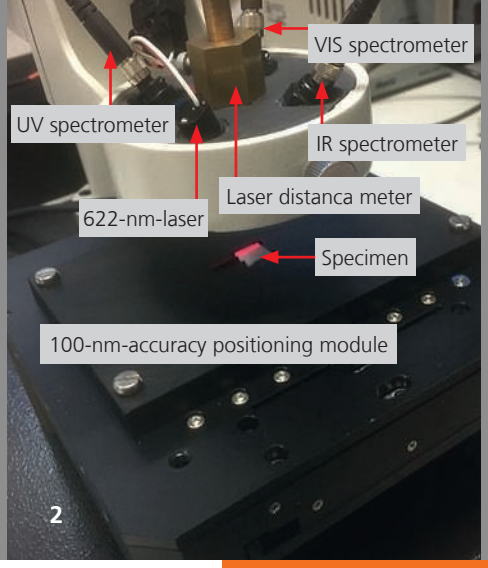

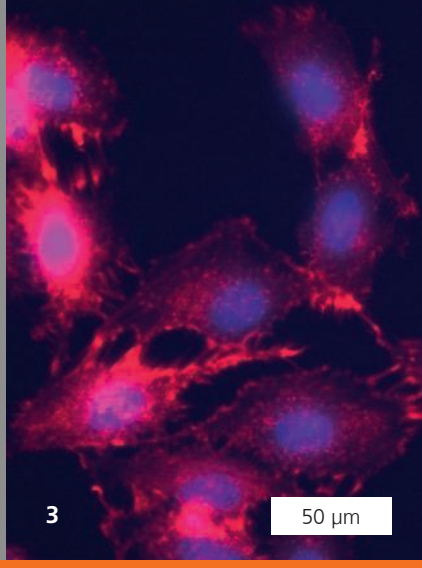

BIOINTERFACE STUDIES IN BIOCERAMICS: IMPROVEMENT OF EXISTING METHODS

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Ceramic materials are quickly establishing themselves as biomaterials in implantology. Up to now, the properties of biomedical materials have been evaluated in in-vitro studies by

- cultivation of cells on the substrate and/or
- incubation of materials in a physiological fluid (e.g., blood)

Numerous factors, including the material surface, protein adsorption, and different cell and tissue types, influence the interactions at the "biointerface", or the boundary between the biological system and the material surface. The biocompatibility of a material is currently evaluated through in-vitro tests based on ISO standards, such as ISO 10993.

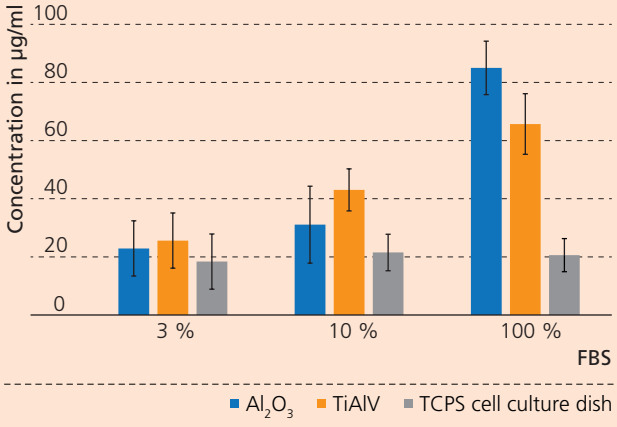
There are only a few standard test methods available for investigating the interactions between the material and blood because of the high degree of complexity of and variations in patient-specific blood response. Contact of the biomaterial with blood leads to activation of blood coagulation and inflammatory responses. The first phase (primary adhesion of blood proteins) is essential for initiation of an immune response and is the focus of the research performed in the ATTRACT group at Fraunhofer IKTS. The aims are to improve standard laboratory methods and to establish new nanoscale-resolution technologies (e.g., AFM) as standard test methods for enabling detailed analysis of protein adsorption on bioceramic and other material surfaces in the future.

Methods

Protein detection and quantitation:

- Raman spectroscopy, atomic force microscopy (AFM), fluorescence microscopy, confocal microscopy, ellipsometry
- Multispectral, nanoscale raster analysis
- Colorimetric assays for protein quantitation, e.g., based on bicinchoninic acid (BCA assay)

BCA assay for determining amount of protein (fetal bovine serum, or "FBS") bound to various surfaces



Imaging methods for specific cell types:

- Fluorescent dyes
  - Specific cytoskeletal proteins: cell adhesion and morphology
  - Live/dead dyes: cell vitality and growth
- Material-protein-cell interactions via AFM and SEM

1 *AFM measurement made on polished Al_2O_3 coated with BSA.*
2 *Raster measuring device.*
3 *Bone cells (MG-63) following one hour of incubation on a polished (FBS) protein-coated Al_2O_3 surface (red = F-actin, blue = cell nuclei).*

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