BIO-NANOTECHNOLOGY APPLICATION LAB (BNAL) IN LEIPZIG, GERMANY

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The Bio-Nanotechnology Application Lab BNAL is a joint initiative of Fraunhofer IKTS and Fraunhofer IZI. At the location of the Fraunhofer Institute for Cell Therapy and Immunology IZI in Leipzig, the resources of both institutes are combined in a joint project. For the laboratory equipment, 3 million euros were granted by the European Regional Development Fund (ERDF).

The BNAL equipment enables, for the first time, the concentrated processing of interdisciplinary topics – from the biological-medical basic research, to process engineering, to the development and validation of the latest technologies and system solutions. The laboratory and process unit serves as basis for research and development cooperations with internationally leading companies or research institutes. By combining ultramodern equipment and technical expertise of two Fraunhofer institutes, it is possible to address new contacts and open up new topic areas for existing contacts.

Fraunhofer IKTS uses this cooperation in order to advance its analysis methods and measurement devices according to current issues and, therefore, to tap into new applications and technology areas. At BNAL, biological issues should be processed with the following innovative measurement methods:

1. The Optical Coherence Tomography (OCT) provides spatial high-resolution information from the examination object. One essential aspect of cytological research is the characterization of cell surfaces. The planned systems target the structural and chemical analysis of biofunctionalized surfaces. In addition, plasmonic nanosensors enable the direct study of the temporal process course at cell membranes. Examples for such processes include the absorption of agents from the drug delivery systems, the coupling of viruses to the cell or the tracking of the cell division, e.g. for the evaluation of division rates.

2. The eddy current-based impedance spectroscopy allows for the temporally resolved and randomly repeatable measurement of a system (e.g. antigen/antibody, analytes) as contact-free measurement method. As the process is transferable to smallest volumes, differentiated proofs of substances can be performed, cell measurements for medical diagnostics taken, therapeutic substances developed or the temporal course of polymerization processes of organic substances analyzed. Drawing an inference regarding diseases of biological tissue by measuring the impedance spectrum opens up a broader application field in the medical sector.

3. The ultrasonic spectroscopy is currently applied not only in analytics of fluid media but also in medical diagnostics, e.g. the analysis of cell tissue and other biological materials. There, changes of the mineralization or molecular chains affect the mechanical properties of the system. The changed velocity and attenuation of an ultrasonic wave enables to quantitatively determine elastomechanical properties of biological tissue and large organic molecules. Thus, different tissue types can be identified or pathological conditions analyzed.

4. At BNAL, a scanning acoustic microscope is available, which prospectively integrates the photoacoustic microscopy in addition to the acoustic and optical microscopy. Via acoustic or photoacoustic excitation, spatial changes of the mechanical impedance can be detected within biological materials. This enables the analysis of the structural constitution of a sample over various length scales. Furthermore, organisms, organs and individual cells up to cellular components (organelles) can be mapped and characterized. This multiacoustic microscopy allows for deeper insights into the 3D structure of biological systems on a very small level.

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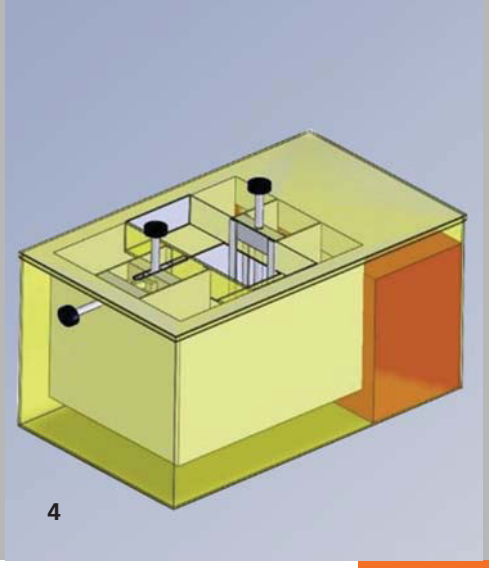

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5. Technical possibilities exist of late, which are able to miniaturize immunological and microbiological inactivation or sterilization and integrate them into process courses. For that reason, BNAL hosts a plant for electron irradiation as well as a dosimetry unit. By irradiating organic material with low-energy electrons, process in that material can be specifically influenced. Thus, cell division and reproduction rate can be controlled, which can extend to the sterilization of a surface populated with cells according to the dose. In addition, different properties of cells and cellular populated surfaces can be manipulated with high precision by irradiation. These properties include roughness, reactivitiy, and the condition of different chemical bonds or the charge. Not only are these parameters important for the behavior of living cells but also particularly for the interaction between substrate and cell.

6. By applying an innovative measurement method for determining the temporally resolved relaxation of the autofluorescence at biological tissue or individual cells, their so far insufficiently characterized properties shall be analyzed. For that reason, a specific fluorescence relaxation spectrometer is available. By means of characterizing non-analyzable properties, the possibility of answering medical or pharmaceutical question presents itself.

These devices are complemented by technical equipment of Fraunhofer IZI, which places its focus at BNAL on the fields of molecular diagnostics, flow cytometry and nanostructuring.

With the establishment of BNAL, ideal requirements are created for an optimal joining and usage of both Fraunhofer institutes' available know-how. The application lab has its sphere of activity in the intersection of cell biology, medicine, biotechnology, nanotechnology and medical technology, and therefore, presents an important connection of the special fields to the Saxon research landscape. At BNAL, the participating institutes offer their pooled expertise to potential customers and create added value through their close cooperation, which each institute could not have generated on its own.

Acknowledgements

We thank the European Regional Development Fund (ERDF) und the Free State of Saxony for financing BNAL's equipment.

1 *OCT measurement device (Source: Evonta-Technology GmbH).*
2 *Multi-Acousto-Scope (Source: PVA TePla AG).*
3 *Irradiation system (Source: COMET AG).*
4 *Impendance analysis system (Source: Suragus GmbH).*
5 *Dosimetry unit (Source: TISAD GmbH & Co. KG).*

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