TECHNISCHE UNIVERSITÄT ILMENAU

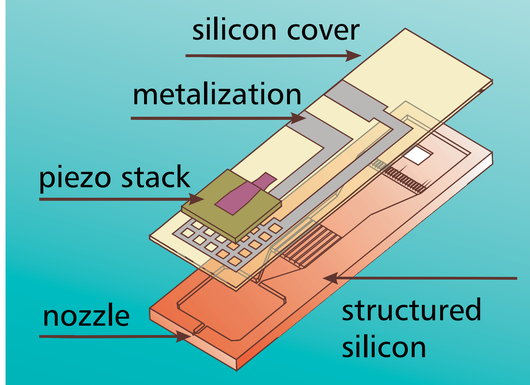
New generation of GaN based sensor arrays for nano- and picofluidic droplets

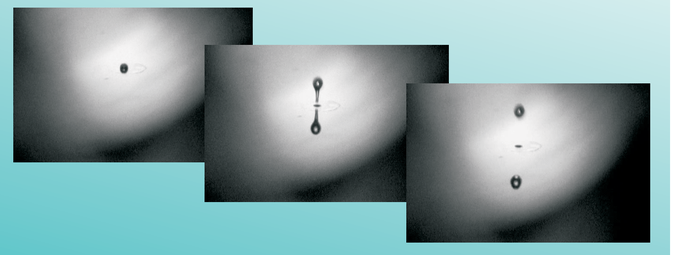
Motivation and goals

The goal of the project is to develop a novel Gallium Nitride (GaN) based integrated system for fast analysis of metabolits, pharmaceuticals, proteins and pathogens in aqueous nano- and pico-droplets. The project explores the frontiers of nanotechnologies through development and integration of electronic sensor arrays, optical components, and a nano-fluidic dosing device, to form a multifunctional system based on GaN micro- and nanostructures. Specific objectives of the project are to:

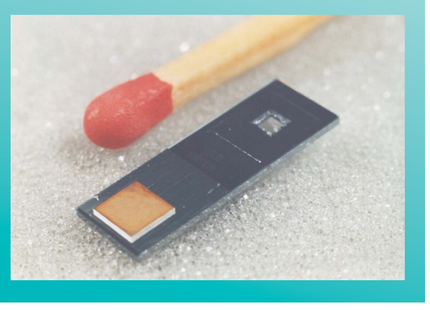
(i) process GaN based *electronic sensor arrays* on transparent chips for chemical and physical analysis of nano- and pico-droplets,
(ii) develop InAlGaN/GaN *optical sensor arrays* combining UV light emitting and laser diodes with *detector arrays* for spatially and energy resolved fluorescence spectroscopy,
(iii) modify an inkjet-like *dosing system* for nano- and pico-droplets containing large biopolymer assemblies such as proteins or viruses,
(iv) develop and apply *organic test substances* and optical markers for nano- and picofluidic systems and *functionalise* sensor surfaces enabling selective biological characterization,
(v) integrate the dosing system with the electronic and optical sensor arrays into a *multifunctional system*.

Dosing system for pico droplets

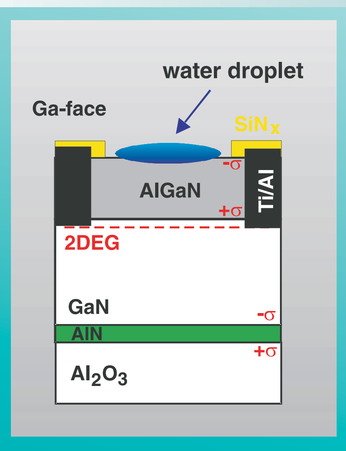


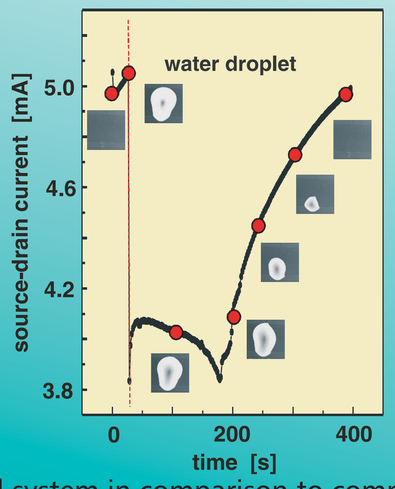


Inkjet like dosing system for nano- and pico droplets of water based liquids. The system provides droplets with volumes between 1 and 50 pL, a spatial precission of < 10 μm and at frequencies between 1 and 300 Hz.



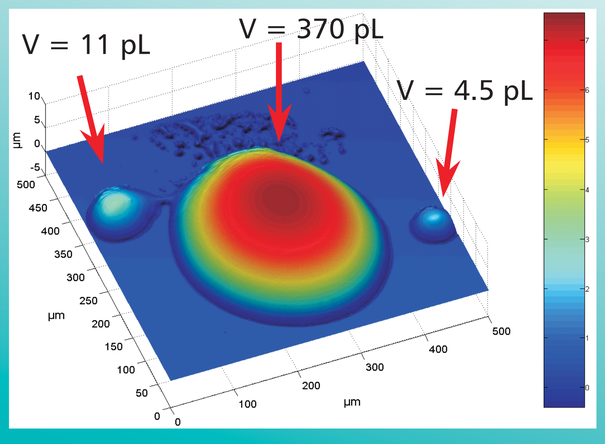
AlGaN/GaN based sensors





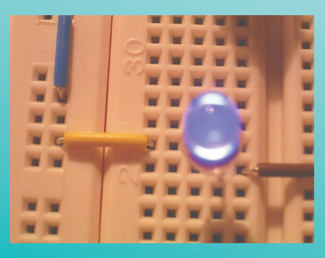
The advantage of the proposed analytical system in comparison to comparable machines is based on the combination of an array of completely transparent GaN based sensors used for the electronic detection of physical and chemical properties of nano- and pico-droplets, with the powerful optical spectroscopy used to identify organic substances embedded inside the droplets.

Determination of droplet size

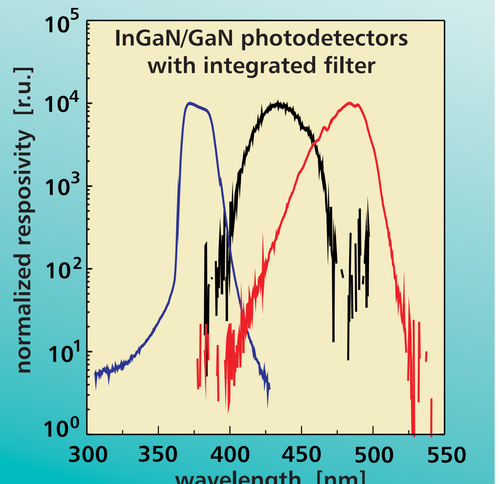


To determine the concentration of organic substances carried by the droplets, the shape of the droplet is determined by optical interference spectroscopy. The optical system is combined with a nanopositioning system enableing a spatial resolution of 200 nm.

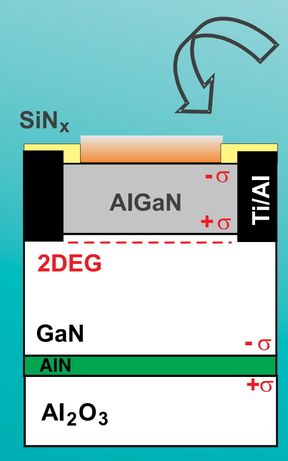
Optical sensor array



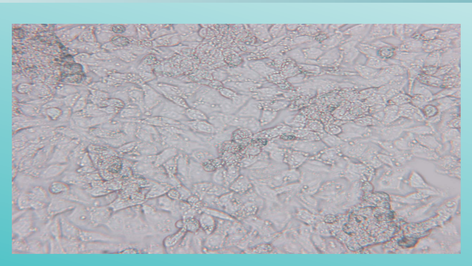
To identify organic substances embeded by the droplets optical spectroscopy is requried. InGaN/GaN heterostructures are processed into optical emitters and detectors sensitive only in a narrow spectral range. This range can be tuned through the visible and near UV.



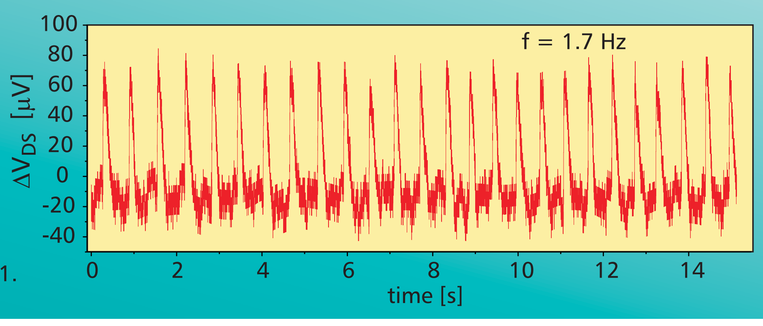
Electronic sensor array



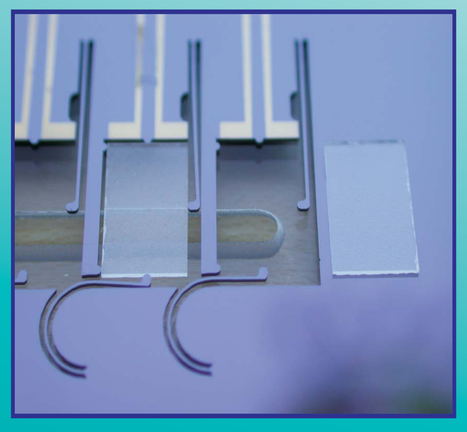
G. Steinhoff et al. APL 86 (2005) 33901.

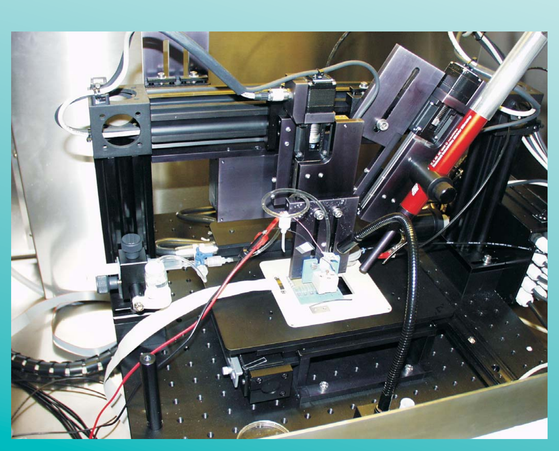


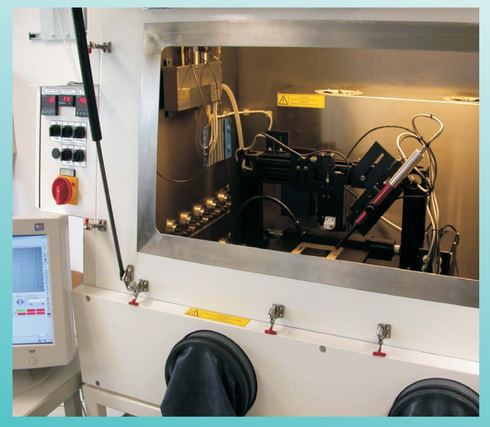
Detection of beats of heart cell clusters by AlGaN/GaN based sensors. The 2DEG carrier concentration of the sensor is sensitive to the self oscillating cell cluster.



Multifunctional integrated sensor system







IThe multifunctional integrated GaNano system combines a dosing system, a positioning unit, an optical sensor array, as well as an electronic sensor array for the sensitive and reliable detection of organic substances in droplets. To provide a controlled contamination free environment the prototype is installed inside a glove box.

Project and partner

The GaNano consortium is composed of nine groups from higher education and research institutions:

Technical University Ilmenau (ZMN),
Technical University Munich (WSI),
University of Crete (UoC),
Foundation for Research and Technology Helas (FORTH),
Universidad Politecnica de Madrid (UPM),
High Pressure Research Center (Unipress),
TopGaN Ltd.,
European Aeronautic Defence and Space Company (EADS),
and Analytik Jena AG.

Project participants are specialists in the field of GaN based hetero- and nanostructures as well as in the development of new technologies and modern materials. Further information is provided at http://www.ganano.eu.org
or http://www.tu-ilmenau.de/site/fke_nano

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