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BIOSYNTH – Modular high-throughput micro-platform for mass data storage of the future from synthetic biology

DNA, RNA and PEPTIDE as storage media

Within the project "BIOSYNTH- Modular High-throughput Micro-Platform for Future Mass Data Storage from Synthetic Biology", funded by the Fraunhofer-Gesellschaft in an internal program, an innovative microchip platform for efficient cell-free and digitally controllable biosynthesis will be developed. The Fraunhofer Institute for Organic Electronics, Electron Beam and Plasma Technology FEP is the consortium leader and will work together with the Fraunhofer Institutes for Photonic Microsystems IPMS, for Toxicology and Experimental Medicine ITEM, for Cell Therapy and Immunology, Bioanalytics and Bioprocesses IZI-BB on the fundamentals for the mass data storage devices of the future with extremely high storage density.

DNA is known as the basic medium for storing genomic information. However, DNA can also be used to store (binary) data – a future technology that has so far been subject of basic research in Europe. This involves transferring microbiological processes from nature to artificial data systems. Writing DNA on microchips is still a big challenge, but also a huge opportunity. For example, information can be stored in very high density directly on a microchip by means of the specific three-dimensional and digitally controllable arrangement of base pairs.

The BIOSYNTH project therefore bundles the know-how of four Fraunhofer Institutes with the aim of significantly improving DNA synthesis. This is achieved by a universal platform for DNA / RNA / peptide writing. Previous synthesis approaches (including ink-jet) are inefficient in generating long DNA segments. Moreover, they generate numerous inaccuracies, which are time-consuming and expensive to correct. In addition, the corresponding equipment technology is large and cost-intense.

"The BIOSYNTH project therefore aims to lay the technological, biological and information technology fundamentals for biological mass data storage with extremely high storage density and aging resistance", explains Dr. Uwe Vogel, consortium leader from Fraunhofer FEP.

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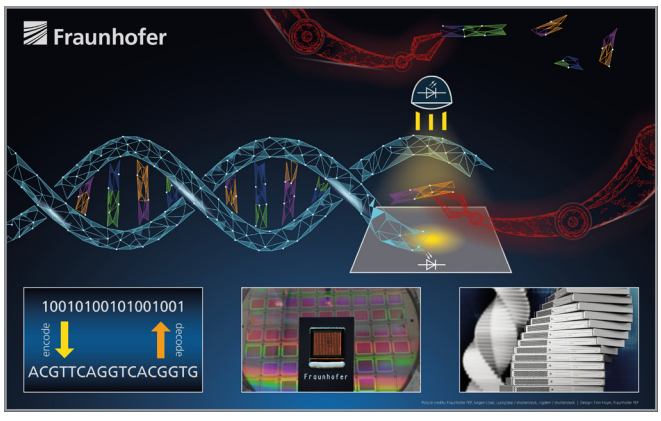
For this purpose, the project will present a platform based on conventional microchip fabrication technologies for writing software-defined nucleotide sequences (DNA, RNA or peptides). This will then enable the highly parallel and high-rate production of mass data storage by reproduction in the volume production process of the microelectronics industry in the future. In a micro-platform designed and manufactured using microelectronics methods, micrometer-level miniaturized reaction cells with picoliter-scale reaction volumes for cell-free synthesis will be integrated into a freely programmable active matrix array assembly.

The transport, immobilization, activation and monitoring of the process conditions and results are carried out by means of suitable thermal and photonic components as well as surface functionalization per reaction cell.

The Fraunhofer FEP designs the integrated circuit of the CMOS backplane to control and read out the micro-heaters for biosynthesis, the OLED and photodetector pixels in the active matrix arrangement and a corresponding test setup. The task of the Fraunhofer IPMS is to develop the "thermo"-layer for the microchip platform. The heating function for adjusting the temperature for biological synthesis is performed by structures in surface micromechanics based on the technology of capacitive micromachined ultrasonic transducers (CMUT). In addition, Fraunhofer IMPS contributes the simulation expertise for thermal functionality. The task of the project is then to implement a MEMS technology in which organic components (organic light-emitting and photodiodes) from Fraunhofer FEP can be integrated to stimulate and monitor the synthesis process.

Subsequently, colleagues at Fraunhofer IZI-BB in Potsdam will implement the synthesis process using the microchip platform. The Fraunhofer ITEM is working on the corresponding coding processes in biological components.

The project is accompanied by a group of renowned consultants from industry, science and users as well as experts from the University of Marburg, XFAB, Infineon, the Federal Archive and Hybrotec. The first results will be presented to the public in an application and user workshop at the end of 2023.



DNA, RNA and PEPTIDE as storage medium of the future – project BIOSYNTH
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About the project „BIOSYNTH“:

BIOSYNTH – Modular high-throughput micro-platform for future synthetic biology mass data storage

Funded by the Fraunhofer-Gesellschaft e.V. in an internal program (PREPARE).

Duration: 1 June 2022 – 31 May 2025

Project partners:
- Fraunhofer Institute for Organic Electronics, Electron Beam and Plasma Technology FEP
- Fraunhofer Institute for Photonic Microsystems IPMS
- Fraunhofer Institute for Cell Therapy and Immunology, Department of Bioanalytics and Bioprocesses IZI-BB
- Fraunhofer Institute for Toxicology and Experimental Medicine ITEM

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- Jörg Schenk, Hybrotec GmbH, Potsdam

Application Workshop 2023:

The first results of BIOSYNTH will be presented to the public in an application and user workshop at the end of 2023.

If you are interested in participating, please get in touch with the following contacts so we can consider this for the program:

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