Decorating DNA sequences with colourful nano-light for improving data storage

CIC biomaGUNE participates in the European project DNA-FAIRYLIGHTS, in a consortium made up of leading research entities

The project aims to implement a novel methodology that may enormously increase the data storage capacity of current devices

Donostia- San Sebastián, 22 December 2021. DNA digital data storage is one of the ultimate technologies that scientists are investigating to have efficient and low-cost alternatives for data storage in the future. The European-funded project DNA-FAIRYLIGHTS aims at synergies of this bioinspired technology with nanomaterial science in order to decorate DNA sequences with colourful nano-lights to enable faster read/write processes and novel data encoding concepts.

The project, in which CIC biomaGUNE Ikerbasque Professors Luis Liz Marzán and Aitziber L. Cortajarena are participating, is coordinated by researchers from the Italian Institute of Technology (Genoa, Italy), and involves an interdisciplinary team of leading researchers: DNASCRIPT (France), University of Cambridge (UK), Elements (Italy), Eidgenössische Technische Hochschule Zürich (Switzerland), Technische Universität München (Germany), Universität Stuttgart (Germany), AB ANALITICA (Italy). The project has been funded by the European Union under the Horizon 2020 framework program with 3.1 million euro for the next 3 years.

Today's society has been producing an ever-increasing amount of data that is rapidly skyrocketing. Digital data is stored is in the form of bits as a series of ones and zeros, and every person generates multiple billions of such data bits that need to be stored on devices such as mobile phones, smart watches, computers, tablets. In view of a sustainable society, new, smart and energy efficient technologies to store data with an extremely small footprint are paramount. Here nature offers a powerful solution: DNA, where the information that defines our organisms is encoded in unique sequences of four bases (A, T, C, G).

Mass data storage with DNA

Using DNA molecules as information carriers in modern technologies enables unprecedented high storage density, long-term stability, and low fabrication costs. However, to unlock the potential of DNA data storage, some key obstacles need to be overcome: the currently slow reading of the DNA sequence, the inability for quick reconfiguration that would be at the base for read/write processes, and the costly ex-nuovo fabrication of the targeted DNA sequence by enzymatic synthesis.

The DNA-FAIRYLIGHTS project aims to lift the digital data storage on a new level by increasing the binary zero/one concept to the broad spectrum of different colours, where multiple colours integrated in the DNA sequence can encode information in a more compact fashion. The key idea

is to decorate the DNA sequence with a series of ultrasmall nanoparticles that have different colours, and to read this sequence with optical technologies that are faster than electrical ones, and also more energy-efficient because they dissipate much less heat. The unique recognition capability of single DNA strands will be used both for defining the sequence, that is encoding the data, and for sequence reconfiguration that allows to modify and re-write the data.

The project will develop novel nanomaterials for light encoding, create new algorithms for data storage beyond the binary zero/one level, design innovative reader devices, and build the resources for science tech industries of the future.

'The aim of this ambitious project is to implement a novel methodology that may enormously increase the data storage capacity of current devices,' explains Aitziber L. Cortajarena. The combined experience of the CIC biomaGUNE laboratories will make a key contribution to designing these codes: 'CIC biomaGUNE will mainly develop a library of metallic nanoparticles and ultra-small light-emitting nanoclusters, and to ensure their controlled assembly in DNA templates,' adds Professor Ikerbasque. 'We estimate a data storage capacity up to 100 times greater than that provided using current technologies. It is not hard to imagine the impact that this technology may have on the electronic components industry,' says Ikerbasque professor Luis Liz Marzán.

About CIC biomaGUNE

The Cooperative Biomaterials Research Centre, CIC biomaGUNE, is a member of the Basque Research and Technology Alliance (BRTA) and carries out cutting-edge research on the interface between Chemistry, Biology and Physics, with special focus on the study of the properties of biological nanostructures at a molecular scale, and their biomedical applications. In 2018 it was officially designated a 'María de Maeztu' Unit of Excellence for complying with certain requisites denoting outstanding quality in the field of research at a worldwide level, coupled with a high level of impact and a high degree of competitiveness.