PRESS RELEASE

A retinal implant developed by BIST researchers could restore the vision of millions of people

- **A project to develop a new retinal prosthesis (THEIA) has won the second phase of the BIST Ignite Program, along with a project to map genes (GenStorm), and a project to characterize new catalysts that allow separation of oxygen and hydrogen from water (InWOC).**
- **The new graphene-based implant will aim to address the visual degeneration caused by diseases such as retinitis pigmentosa, a condition that affects one out of every 3,700 people worldwide.**

Barcelona, January 17, 2018. A healthy retina contains photoreceptor cells that convert light changes into nerve impulses, which are then carried along the optic nerve to the brain, where they are decoded into images. Diseases such as retinitis pigmentosa cause the photoreceptor cells to stop functioning, while the rest of the eye remains healthy. "What we are developing is an electronic device that would be placed into close contact with the retina, with a series of electrodes that would stimulate the ganglionic neurons that are responsible for sending impulses to the brain. The electrodes of the device would partially replace the function of the damaged photoreceptor cells", explains **José Antonio Garrido**, ICREA professor, researcher at the Catalan Institute of Nanoscience and Nanotechnology (ICN2), and one of the members of the THEIA project (acronym for “Towards the implementation of a multi-electrode array for retinal prosthesis”).

The main material of the new prosthesis is graphene, a substance formed by carbon atoms that are bonded in hexagonal structures only one atom thick, which makes it both extremely resistant as well as flexible.

Some clinical studies of devices that insert electrodes into close contact with the retina have already been carried out and have had relatively positive results in terms of vision recovery, "but the stimulation of ganglion cells is complex", explains Professor Garrido, "because the electrical impulses need to have a strong enough charge to achieve the required stimulation but must not do any damage to the cells. The metal-based electrodes that are currently in use are made of either gold or platinum, inert materials that do not cause rejection but are not able to generate a high enough charge for optimal stimulation. Graphene is not only inert and flexible, but it is much more efficient at generating electrical impulses".

Will it be possible to fully recover vision with these new implants? The current retinal prostheses, with around 60 electrodes per device, allow patients to see large shapes again (such as doors and stairs) and even some large letters. "With graphene we could make smaller electrodes, meaning we can use more of them. We could be talking about up to a thousand electrodes per prosthesis, which could generate more concentrated impulses and much more precise stimulation, "explains Professor Garrido. Of course, the development of such a device presents complex and multidisciplinary challenges: the design of the electronic system in which the electrodes are inserted, the sending and receiving with of the electrical signal generated by the images with wireless technologies, the clinical

requirements for the implantation of the device, etc. The combined capabilities of ICN2, the institute that hosts Dr. Garrido, The Institute of Photonic Sciences (ICFO), which hosts the second project leader, **Professor Pablo Loza-Álvarez**, and the Institute for High Energy Physics (IFAE), where the third project leader, **Professor Mokhtar Chmeissani** works, as well as "the clinical vision provided by **Dr. Jeroni Nadal**, of the Center Oftalmològic Barraquer" have been key to the success of the first steps of the project.

In the "seeding" phase of the **BIST Ignite Program**, the THEIA project demonstrated the potential of the new device through "in vitro" tests with rodent retinas. With the funds received in the second phase of the program, a flexible prototype will be developed throughout 2018 for "in vivo" testing with animal models, specifically with dwarf pigs whose eyes have many similarities to those of humans.

"We are talking about a project that will require between 10 and 15 years of work before the device becomes commercially available, but whose potential is enormous, because it could also offer a solution to macular degeneration, and could even become the basis for neuronal implants that would help with a myriad of other diseases", underlines Professor Garrido.

The **THEIA** project, as well as the **GenStorm** and **InWOC** projects, have been selected as the best of the eight that participated in the first phase of the **BIST Ignite Program**. This program was launched **to promote multidisciplinary research and collaboration between groups within the BIST centers**, with have complementary capabilities but are physically separated, which is generally considered a barrier to collaboration. The results have far exceeded the initial forecasts, both by the number and by the quality of the projects presented. During the first call, launched in December 2016, 21 proposals were submitted, and although the initial plan was to provide grants to five of these projects in the "seeding" phase, the scientific ambition of the projects presented was so high that the evaluation committee recommend that BIST expand the selection to eight projects. In the second phase, similarly, the plan was to select the two best projects, but evaluation committee has extended this to three projects due to their high potential for impact. The funds that have been awarded to projects in the first edition of the BIST Ignite Program total 300,000 €.

GenStorm

GenStorm – An integrated approach to visualize and model the spatial conformation of genes at the nanoscale level is a project that was very highly rated by the evaluation committee for both its novel scientific approach and potential as well as the fact that it is led by two young postdoctoral researchers: **Dr. Marie Victoire Neguembor**, of the Center for Genomic Regulation (CRG) and **Dr. Pablo Dans Puiggrós,** from the Institute for Research in Biomedicine (IRB Barcelona).

Their research aims to contribute to the knowledge and understanding of the functions of genes, something we currently have rather limited information about. To do this, the project combines high resolution microscopy with molecular modeling of epigenomic data (that is, how environmental factors or age influence the activation and deactivation of genes without changing the DNA structure) to reveal the three-dimensional structures that genes adopt in the cell nucleus. The researchers believe that the evolution of these structures over time could help us to better understand their functions. Through its multidisciplinary approach, which combines cell biology, nanoscopy, genomics, and molecular simulations, the project has laid the foundations of a new methodology to achieve a much deeper understanding of the spatial arrangement and function of genes.

InWOC

Professor José-Ramón Galán-Mascarós (ICIQ) and **Professor Jordi Arbiol** (ICN2) lead the InWOC project - **In-situ advanced characterization of heterogeneous water oxidation catalyst: Towards photocatalytic water splitting**, whose objective is to identify and characterize new catalysts (economical and accessible) that will allow for the separation of oxygen and hydrogen from water molecules.

Hydrogen is considered a key component in the replacement of fossil fuels with clean energy, but nowadays 96% of its production is accompanied by the polluting fuels that it aspires to replace. The lack of an accessible and economical catalyst to obtain H2 through the electrolysis of water (currently noble, expensive and scarce metals are used) creates a barrier for the generalized use of this form of clean energy.

The InWOC project has developed a new methodology for the characterization of nickel and iron oxides, which have great potential as competitive catalysts for water oxidation. Studies are still required however, to understand their mechanisms, optimize their activity, and identify the optimal conditions for their implementation. The new methodology proposed by InWOC combines electrochemistry, electron microscopy, and synchrotron spectroscopy.

Second edition

This week, the call for the seeding phase of the second edition of the BIST Ignite Program closes, with the expectation of a higher number of proposals. The five winning projects of the first phase of this second edition will be announced in mid-March. By the end of 2018, the two best projects will be selected from these five, which will receive additional resources to continue with the research.

Sobre el BIST

About the BIST

The Barcelona Institute of Science and Technology (BIST) is an initiative of seven research centers of excellence in Catalonia whose objective is to increase their collaboration in order to build a common scientific project. Its strength is based in the research capacity of its centers and in its potential to promote leading multidisciplinary research projects. The centers of the BIST are the Center for Genomic Regulation (CRG), the Institute for Bioengineering of Catalonia (IBEC), The Institute of Photonic Sciences (ICFO), the Institute of Chemical Research of Catalonia (ICIQ), the Catalan Institute of Nanoscience and Nanotechnology (ICN2), the Institute for High Energy Physics (IFAE), and the Institute for Research in Biomedicine (IRB Barcelona).

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Notes:

- The coordinators of the THEIA, GenStorm and InWOC projects are available for interviews. If you are interested, please contact BIST.
- You can find more information about all projects of the first BIST Ignite Program on the BIST website (bist.eu) and through the following links: THEIA, Calix4Trans, GenStorm, Zpro, Nirgraph, Etango, Oxiflowpas, InWOC.