

PRESS RELEASE 48/2024

An optical filter at the service of medicine

A research team from the Institute of Photonics and Nanotechnologies of the CNR and the Politecnico di Milano has developed a special optical filter that, when applied to Brillouin spectroscopy techniques, enables the measurement of the elasticity of sub-cellular structures such as bone tissues. This innovative device, described in Nature Communications, was developed in collaboration with Specto Photonics.

A team composed of researchers from the Politecnico di Milano, the Institute of Photonics and Nanotechnologies (CNR-IFN), the Institute of Genetic and Biomedical Research of the National Research Council of Milan (CNR-IRGB), the start-up Specto Photonics, also based in Milan, and Humanitas, has developed an innovative birefringent optical filter that allows for increasingly precise measurement of the elasticity of sub-cellular structures such as bone tissues.

Brillouin spectroscopy is an advanced optical technique that provides access to the mechanical properties of organic and inorganic on a microscopic scale and without physical contact. This non-invasive technique already has multiple uses in the biomedical field, allowing, for example, in vivo and 3D measurement of the elasticity of sub-cellular structures, which is crucial for studying diseases such as osteopetrosis. Despite its potential, the use of Brillouin spectroscopy is still limited today because it relies on detecting a very weak optical signal, which unfortunately is overwhelmed by optical disturbances approximately a billion times stronger, thus hindering its detection. These disturbances are inevitably due to the light used to excite the sample and are even stronger when the material is turbid.

To overcome this obstacle, the team designed and developed an innovative optical filter, called the Birefringence-Induced Phase Delay (BIPD) filter, whose properties are described in an article published in *Nature Communications*. "This extremely compact filter is capable of suppressing the strong disturbances caused by the excitation light with an unprecedented level of attenuation. Thanks to the filter, it was finally possible to acquire high-resolution images of the elastic properties of various samples where optical disturbances are usually dominant, such as bone tissues," explains Cristian Manzoni, a researcher at CNR-IFN and one of the authors of the work. "The goal now is to provide a device that enable the investigation of the mechanical properties in opaque tissues, which were previously inaccessible with conventional techniques," continues Giuseppe Antonacci of Specto Photonics.

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A first test was conducted on a murine model affected by osteopetrosis, a rare genetic disease characterized by a higher bone density than normal. The BIPD filter allowed for the observation of significant alterations in the mechanical properties of the animal's bones on a micrometric scale.

"This was an important step forward towards the increasingly widespread use of Brillouin spectroscopy in clinical and diagnostic applications," concludes Giulio Cerullo, professor at the Politecnico di Milano and one of the authors of the work.

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Who: Politecnico di Milano – Dipartimento di Fisica; Istituto di fotonica e nanotecnologie del Consiglio nazionale delle ricerche di Milano (Cnr-Ifn); Specto Photonics; IRCCS Humanitas (Rozzano, Milano); Istituto di ricerca genetica e biomedica (Cnr-Irgb) - UOS di Milano

What: Antonacci, G., Vanna, R., Ventura, M. et al. Birefringence-induced phase delay enables Brillouin mechanical imaging in turbid media. Nat Commun 15, 5202 (2024). <https://doi.org/10.1038/s41467-024-49419-2>

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