FRET imaging of neuronal contacts with diamond nanopillars electric field sensor

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Neurons communicate with each other via synapses. Little is known about electrical potential at the synapse submicron scale, even though it plays a key role in synaptic transmission. The **LuMIn** team is setting up an optical sensor of neuron electrical activity with 200 nm and 1 ms spatial and temporal resolutions, based on quantum properties of nitrogen-vacancy (NV) defects in a diamond nanopillar array.
The quantum sensing setup has been built and is currently qualified using test electric field sources. In parallel we are tackling different challenges related to the specificity of the **neuron-to-sensor interface**. One of them, which is the heart of this project, concerns the electric field screening by culture medium ions on distance as short as 1 nm (Debye layer). To avoid such screening, it is critical that neuronal branches are tightly connected to the pillars. To measure the distance between the neuron membrane and the pillars, we will take advantage of **I2BC** team expertise and use Förster resonance energy transfer (**FRET**) that takes place only on a distance of a few nanometers. The FRET pair donor will be a semiconductor nanocrystal, while the acceptor will be a fluorogenic cell membrane dye.

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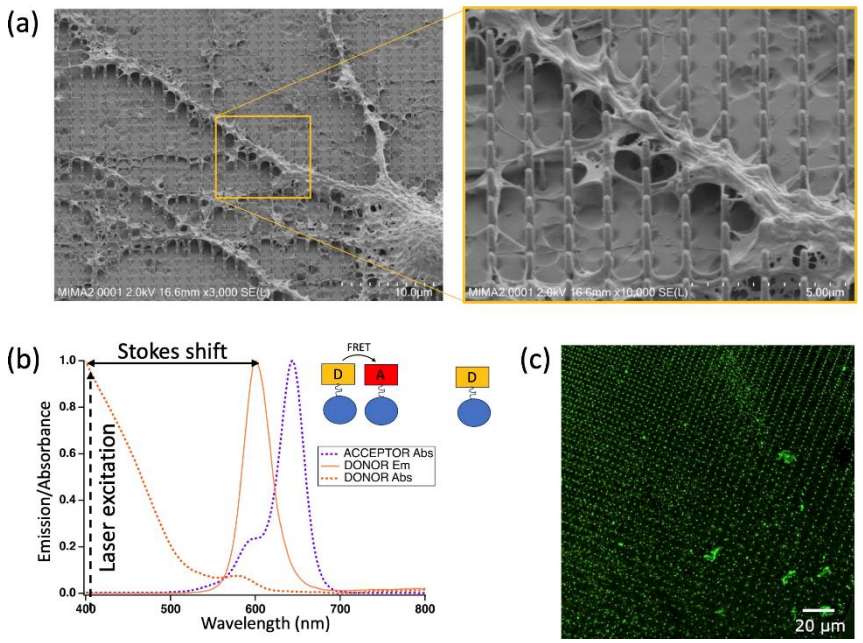

Measuring by FRET the distance between neuronal membrane and the diamond nanopillar array substrate. **(a)** Mouse hippocampal primary neuron grown on diamond nanopillars. Nanopillars: X. Checoury [C2N] & L. Hanlon; neuron culture: B. Potier & B. Grimaud, **LuMIn**; SEM: V. Costache [INRAe]). **(b)** FRET couple spectra in the case of a QD donor (D) and a dye acceptor (A). A large overlap between donor emission and acceptor acceptor spectra allows efficient FRET. **(c)** Confocal fluorescence scan (405 nm excitation wavelength) of a diamond nanopillar array (uneven period) covered with QD-laminin, decorating them efficiently.