Single-DNA detection on a chip for the monitoring of micropollutants in water

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Based on the single-DNA chip we have designed for fundamental studies of various DNA processes, we work at developing a sensor with the capability to detect traces of substances in water.

Our device relies on the video-monitoring of a particle attached to the free end of a DNA molecule immobilized by its other end to a support. The motion of the particle reports the DNA conformation changes at the single molecule level (Fig A). This method permits to detect modifications on the DNA molecule with very high sensitivity and to reveal rare events not accessible using standard averaging approaches. In order to parallelize these measurements, we have conceived a biochip which allows the real-time monitoring of about 1000 molecules simultaneously[1,2], offering a direct access to statistically reliable results (Fig B).

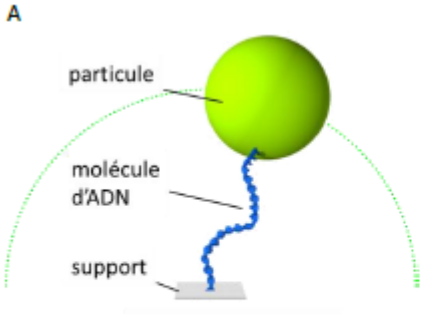

Fig A. Principle of the detection: a particle bound to the immobilized DNA molecule is tracked by videomicroscopy. The analysis of the trajectory of the particle estimates the conformational changes of the DNA molecule.

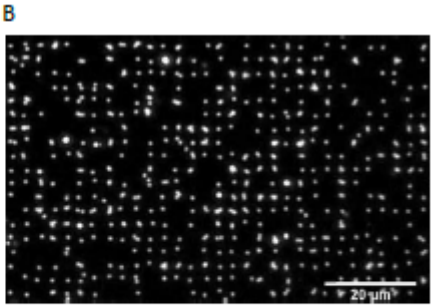

Fig B. Partial view of the field of observation of the single-DNA chip. About 1000 particles are observed and analyzed in real-time.

The method is compatible with natural waters and we have already shown that it is sensitive to the presence of a variety of herbicides and drugs and could thus be utilized as a sentinel system.

The implementation of molecular biology tools such as aptamers should allow to go one step further and make our single-DNA chip a specific and selective sensor of substances in water.

1. Patent FR n°1057031 filed September 3, 2010, "Biopuces pour l'analyse de la dynamique de molécules d'acide nucléique" ; EP n° 2 611 940 B1, delivered April 8, 2015.
2. Plénat, Tardin et al., "High-throughput single-molecule analysis of DNA-protein interactions by tethered particle motion", Nucleic Acid Res., 2012