

Paper-based microfluidics self-supplied with hydrogen peroxide

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Nowadays, there is a growing demand to determine a specific compound not in a specialized laboratory but on-site. As examples, one might imagine diagnostics tests conducted by patients themselves, detecting explosives in the luggage at airports, or determining illegal doping substances in blood or urine of athletes. For these purposes, disposable, inexpensive, ecological and most importantly, accessible to be used by an unskilled user, tests should be employed. A perfect material candidate for manufacturing such tests is paper; it fulfills all of the mentioned requirements. In most cases, the reagents necessary to conduct a chemical reaction, which is the ground for the determination of the target compound (for example resulting in a colorful or luminescent product), are pre-deposited in paper, dried and stored in such form until the paper-based sensor is used.

Unfortunately, this approach fails even in the case of such a simple chemical as hydrogen peroxide (H_2O_2). It turns out that when the solvent evaporates, hydrogen peroxide decomposes, which makes it impossible to pre-deposit this reagent on paper-based sensor and use the sensor after a certain period. Hydrogen peroxide is an essential reagent in analytical chemistry; it allows to conduct many key assays in various fields of this discipline. For instance, due to its presence luminol can emit light, it is also necessary for many immunochemical methods. If it were possible to ensure the stability of H_2O_2 on paper, all of these assays could be executed in paper-based format.

Considering that this chemical cannot be introduced and stored within paper matrix like other reagents, it is essential to search for an alternative approach. This project aims to explore two possible paths to manufacture paper-based microfluidics exploiting hydrogen peroxide as one of the assay's reagents – one of the possibilities is its generation in situ by a photochemical reaction just before the planned usage of the sensor. The second method is to store H_2O_2 in silica xerogel (dried hydrogel) until the paper-based sensor is used. The graphics in the bottom demonstrates the conceptual scheme of the project. Achieving the goal of the project will allow to develop paper-based sensors for the determination of a variety of analytes, employing assays, which require hydrogen peroxide (exemplary assays are shown in the right side of the graphics: methods using antibodies conjugated with horseradish peroxidase (HRP), chemiluminescent methods with luminol or fluorometric creatinine determination).

