Magnetic Nanoparticles and Sensors for Rapid Diagnostic Testing for Health Care: Application to Pneumonia, Histamine, and COVID Antibodies Detection

Montserrat RIVAS - *University Oviedo, Spain*

Early detection of disease biomarkers, toxins, and infectious microorganisms is a major goal in modern health care, environmental control, and food safety to help contain and reverse illness or prevent contaminants from entering the food chain.

To achieve it, materials scientists develop biosensing platforms whose requirements may differ depending on the application. When biosensing is a tool for screening or point-of-use applications (e.g., at the patient's bedside, the industrial plant, or harsh environments), it must be fast, low-cost, and easy to use and transport. Lateral flow immunoassays (LFIs) meet these requirements. They are paper-based tests, whose most recent example is the rapid diagnostic tests for SARS-CoV2. There are some limitations for LFIA expansion, mainly their sensitivity (frequent fake negatives) and detection limit, which are not sufficient for some applications. Magnetic nanoparticles and magnetic detectors can be an excellent way to overcome such constraints.

First, iron oxide nanoparticles provide a brownish color that is detectable by the naked eye or on a smartphone camera image. Magnetism can be used for pre-concentration or isolation of the target analyte from the sample matrix, and the magnetic reporters can be relocated closer to the visible membrane surface to increase their visibility.

Second, magnetic nanoparticles produce a magnetic perturbation that a magnetic sensor can detect without optical interference. Additionally, magnetic sensors report particles not only from the paper's surface but from the entire cross-section of the strip. Finally, the magnetic signal from the nanotags does not decrease significantly with time.

We review the principles and design of magnetic LFI and detail the requirements for magnetic nanoparticles to be used as reporters. We address the current methods used to read their signals that do not sacrifice the simplicity and low cost of the paper-based method. As proof of how magnetic LFI can be a useful analytical tool for biomedicine and food safety applications, we give examples of pneumonia biomarker detection and toxin quantification in foods and beverages.