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Optoelectronic noses based on starch films for food spoilage monitoring in smart packaging

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The optoelectronic nose, also known as a colorimetric sensor array, is made up of chemosensitive dyes embedded in a solid substrate. This setup allows the contact of device with the volatile compounds in the sample's headspace. Traditionally, substrates such as polymeric membranes or paper-based materials have been used, but they require time-consuming preparation steps, the use of toxic solvents, and are limited to single-use applications. We present a reversible optoelectronic nose prepared with ten acid-base indicators embedded in a starch-based film that covers a wide pH range. The starch substrate has several advantages, including odorlessness, biocompatibility, flexibility, and high tensile strength. We used this optical artificial olfaction system to detect the early stages of decomposition in three different food products: beef, chicken, and pork. The system recorded color changes caused by intermolecular interactions between each dye and the emitted volatiles over time, using a smartphone. These digital images were then processed to generate a differential color map, which resulted in a unique signature for each food product based on observed color changes. To improve discrimination between different samples and exposure times, we used chemometric tools like hierarchical cluster analysis (HCA) and principal component analysis (PCA). This analytical approach for detecting food deterioration is practical, cost-effective, and user-friendly, making it ideal for smart packaging applications. Furthermore, the use of starch-based films in the food industry is favored due to their biocompatibility and biodegradability properties. These features make it a promising candidate for developing efficient and reusable optoelectronic noses for volatile compound analysis.

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