Advanced Material Platform Based on PEG-Microgels.

Edmondo BATTISTA - *Università degli Studi "G. d'Annunzio" Chieti-Pescara*

Microgels and hydrogel microparticles have emerged as a crucial subclass of hydrogels, offering new functionalities in biomolecule detection due to their highly tunable chemistry. Polyethylene glycol (PEG)-based microgels, in particular, have gained significant attention in recent years as an advanced material platform for various applications, including biosensing, drug delivery, and tissue engineering. These microgels exhibit exceptional characteristics such as hydrophilicity, which allows for better interaction with biological systems, biocompatibility, which ensures minimal adverse reactions in the body, and chemical flexibility, which allows for the incorporation of various functional groups, making them suitable for a wide range of biomedical applications. The chemical flexibility of PEG-microgels allows the incorporation of various functional groups or small molecules into their structure during synthesis, enabling the immobilization of diverse probes such as antibodies, enzymes, or oligonucleotide strands. This feature facilitates the creation of particles active for the detection of specific targets or multiple biomarkers, which is crucial for applications like cancer diagnosis and immunoassays. Moreover, the high biocompatibility and antifouling properties of PEG-microgels enable their use in biosensing directly in biofluids, eliminating the need for washing and separation steps typically required in other detection methods. Another significant advantage of PEG-microgels is their ability to be easily manipulated in flow using microfluidic devices, making detection more efficient and sensitive in a multiplex context. This is particularly important for applications that require the simultaneous detection of multiple biomarkers. Additionally, the PEG-microgel platform can be employed for the detection of circulating oligonucleotides in cancer diagnosis and circulating proteins in immunoassays, indicating its potential as a versatile tool in medical diagnostics. Furthermore, the synthesis and design of microgels have paved the way for innovative applications beyond biomolecule detection. Their unique properties have led to the development of smart drug delivery systems, tissue engineering scaffolds, and responsive materials for various industries. In conclusion, the advanced material platform based on PEG-Microgels presents an exciting avenue for diverse applications, especially in biomolecule detection and analysis. The tunable chemistry, biocompatibility, and integration with microfluidics and other microdevices enable the creation of sensitive and efficient detection systems. As research in this field continues to progress, the potential applications of microgels are expected to expand even further, contributing to advancements in diagnostics, medicine, and materials science and will be explored in detail.