Boosting the shelf-life of food items via "nano-inspired" packaging design approaches

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Abstract

Oxygen is primarily indicted for triggering deterioration/spoilage phenomena in several packaged food products, thereby leading to a loss in their shelf-life. Among other strategies (e.g., modified atmosphere packaging, oxygen scavengers, and antioxidant release systems), the detrimental effects pertaining to oxygen presence can be curbed via the design of packaging systems acting as a "screen" against the transfer of oxygen.

Multi-layer plastic packaging configurations represent the most widely adopted solution for many packaged foods because they offer excellent overall performance – especially in terms of oxygen shielding effect – by combining heterogeneous layers that grant maximum protection. Nevertheless, these systems are known to pose a serious threat from multiple points of view (e.g., environmental, economic, and social) because of current technological limitations which dramatically hamper their recyclability.

Prompted by the more and more compelling legislation devoted to plastic management, the transition toward "mono-materiality", that is, full recyclability, has gained renewed interest in the last few years. Within this scenario, the "coating" deposition of nano-reinforced biopolymers onto petroleum-based plastics emerges as a promising technique to yield high-performing and more sustainable packaging solutions. Upon a tuned loading of targeted compounds to the bio-coating matrices, mono-material packaging systems possessing either superior functionality (e.g., high barrier, mechanical, optical, surface, and thermal properties) or active behavior (e.g., antimicrobial/antioxidant power) could be synthesized, thus standing as a viable and greener alternative to the "heavy" multi-layer systems.

This presentation deals with the development of specific high-oxygen barrier bio-coatings intended to functionalize conventional plastic substrates. Special attention was paid to the "top-down" approach through which a bio-based material, such as cellulose, was converted to nano-sized entities, named cellulose nanocrystals (CNCs). Multiple analytical techniques were involved to characterize both the CNCs and nanocomposite coatings thereof when laid onto polyethylene-terephthalate (PET) sheets, with the main collected results being eye-bird illustrated.