Functionalization of Polyurea Microcapsules to Enhance Binding to the Leaf Surface

Microencapsulation of an active ingredient with a polymeric shell is a technique that has been used for several years now. This trapping technique has a variety of positive attributes such as controlled release of an active ingredient, reduced degradation for sensitive materials if exposed to the environment, reduced mammalian toxicity in presence of very potent molecules.

Encapsulation of pesticides and herbicides is an area that has been widely explored and one of the most common approaches in the industry is the synthesis of a polyurea shell around the active ingredient. This polyurea coating is obtained through interfacial poly-condensation reaction between a variety of diamine and diisocyanate monomers that eventually will determine the properties of the capsules, as release kinetic or mechanical integrity.

The capsules obtained through this process are, most of the time, “naked: in the sense that no functional group is attached on the external surface. In some instances it would be desirable to modify the surface chemistry of those microcapsules to tune and meet requirements for different applications and needs. Some work has been done in the literature using polymers (1), low molecular weight modifiers (2) or negatively charged monomers such as sulfonic groups to improve oxygen binding capacity (3).

In a recent study done internally we have used antibodies as a template and built on it them different domains: one with affinity for the polyurea capsule wall while the other domain has stronger affinity for the leaf surface. A similar approach has been described in a patent published in 2012 (4) where the antibody is designed to enhance the binding of pesticide microcapsules to the exoskeleton of the insects. Even if this approach sounds very appealing, it has to deal with the difficulties related to the synthesis and purification of an antibody and the fact that the antibody is not covalently linked to the capsules so external factors, such as ionic strength of the system, pH or nature of surfactants and dispersing agents, have to be carefully considered if a commercial product is designed.

In the work we are going to present, we followed a different approach. Short peptides sequences were synthesized and attached covalently to the external surface of the capsules. Those so called “hairy capsules” have shown a substantial increase in the number of capsules attached to the surface of leafs vs. the “naked” version, based on

experiment data generated in the laboratory. The overall number of capsules attached is correlated to different factors such as nature of the peptide, numbers of peptide monomers for each capsule, pH of the system. An average increase of 30% was achieved in the total number of capsules linked to the leaf surface. Rice leaf was used as an example for all those tests.

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