PH-RESPONSIVE MICROCAPSULES SYNTHESISED VIA A WATER-IN-OIL-IN-WATER EMULSION TEMPLATE

Calum T.J. Ferguson, Institute of Particle Science and Engineering, School of Chemical and Process Engineering, University of Leeds, Leeds, LS2 9JT, United Kingdom
bsctjf@leeds.ac.uk
R. Elwyn Isaac, School of Biological Sciences, University of Leeds, Leeds, LS2 9JT, United Kingdom
Olivier J. Cayre, Institute of Particle Science and Engineering, School of Chemical and Process Engineering, University of Leeds, Leeds, LS2 9JT, United Kingdom

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Biological agents, such as peptides and nucleic acids (siRNA or dsRNA), are becoming increasingly employed in both the therapeutic and agrochemical industries as alternatives to synthetic chemicals. These agents have a number of advantages, including their specificity for a target, ease of registration and low human toxicity.1
Chemical pesticides are currently the most common method of crop protection, but have a number of drawbacks including their toxicity and effects on non-target species.2 Therefore, there is an ever-shifting move to the use of more eco-friendly biological control measures; however, these also have negative attributes.
Bio-control agents are often unstable3 and, upon ingestion, are subjected to degradation by hydrolytic enzymes and conditions favouring acid hydrolysis. As a result, these water soluble agents must be protected by encapsulation in a water continuous phase. This provides a protective shell, ensuring their stability during delivery and giving the ability to control and trigger release, which facilitates a more efficient use.

Figure 1 – p2VP capsules after 5 minutes in different pH environments.

To achieve this, we have used a water-in-oil-in-water emulsion as a template; where the oil phase is comprised, in part, of a monomer which is subsequently polymerised to form a shell that protects the inner aqueous phase. The microcapsules produced can trigger-release upon pH variation in the continuous phase when the monomer employed is pH-responsive.
This work focuses on the use of poly(2-vinylpyridine) capsules, with a pKa of ~ 4.2, where the tertiary amines on the polymers' pyridine rings become protonated in acidic environments.4 This enables the release of encapsulated species in acidic environments, such as those found in the acidic region of the midgut of many insect pest species. The release of biological insecticides in the midgut is of particular interest, as this is the main site of uptake from the gut into the insect and the obvious target for entry into the pest.3, 5.

The produced capsules can fully dissolve within minutes at low pH, providing a method for complete release of the encapsulates. This is a more favourable method of release compared to the common approach of swelling capsules, due to the large size of the biological encapsulates. Furthermore, biological agents tend to adhere to many surfaces, including polymer surfaces, which can prevent their full release from a swollen capsule, particularly when using small capsule diameters. We have found that our capsules will dissolve in under 5 minutes in a pH 3 environment, as shown in Fig. 1. Furthermore, we have shown that we can induce the dissolution of the capsules at pH 4 in buffering conditions. The work presented will discuss the encapsulation synthesis routes, species that can be encapsulated, and the release profiles of the capsules under differing environmental conditions.

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