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J Adv Chem Eng 2018, Volume 8
DOI: 10.4172/2090-4568-C3-012

5th International Conference on

Advances in Chemical Engineering & Technology

October 04-05, 2018 | London, UK

Development of novel autoreactive and ecological mono-component adhesives

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Microcapsules have been used in many fields, such as food, medicine, pesticides, environmental and biological engineering, cosmetics and coatings, among others. Besides the importance of microcapsules for controlled chemical release and uptake in many industrial applications, these are often difficult to produce with the desired combination of high mechanical strength and high shell permeability.

The encapsulation can be used to protect active agents from oxidation (caused by heat, light, humidity and exposure to other substances over their lifetime), shield an irritating smell, prevent the evaporation of volatile compounds and reduce the toxicity of certain active substances.

Nowadays, the most reactive encapsulations are performed in batch processes to produce microcapsules, ranging from 10–500 μm, in high quantity. However, besides the advantage of batch processes for high throughput production, these techniques do not provide a precise control over the resulting capsule size, dispersity and morphological properties; the encapsulation efficiency is strongly limited by the process conditions.

In this article, we report on a microfluidic approach to fabricate monodisperse isocyanate microcapsules with lipophilic cores and polyurethane shells. These microcapsules are generated in a microcapillary microfluidic device using monodisperse oil-in-water (O/W) emulsion as templates, with strong potential application in aeronautic and automobile industries.

The proposed method has advantages of being readily controlled, cost-effective and easy to operate, together with its ability to produce a uniform size. In addition, microfluidics can control the process of encapsulation by varying flow parameters and/or using a proper geometry of microfluidic channels. By microencapsulating the reactive agent, the product is safer for handling by the industry operators, and the activation mechanism can be controlled more precisely (enabling higher flexibility of application / use case scenarios).

The advances made of the current study can be an important contribution in the innovation and development of new sustainable/green methods and products that can, in the future, compete in the mono-component adhesives market.

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