Silica Nanocapsules

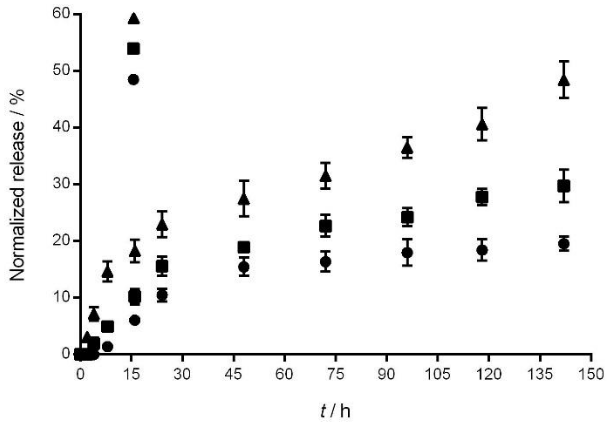
Silica micro/nanocapsules for controllable sustained release of active ingredients including delicate biologics

Potential Application

- Agriculture, veterinary, pest control, functional packaging
- Sustained release of active ingredients including small molecules, bioactives and antigens
- Encapsulation of delicate actives to provide temporary protection prior to release

Potential Competitive Advantages

- Protection of an active ingredient prior to controlled release
- Encapsulation of actives that are larger or more sensitive than small molecules
- Encapsulation (via an emulsion) is independent of release profile
- Large payloads and high encapsulation efficiency possible



Sustained release rate is varied by controlling shell thickness

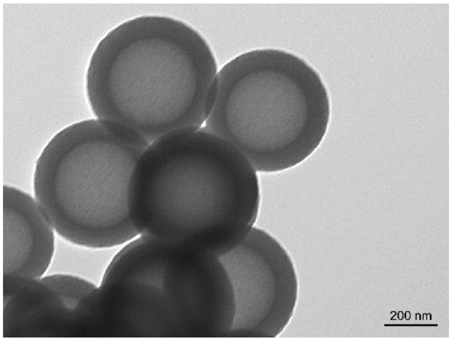


Image of a silica nanocapsule

The Technology

Designed peptide or protein surfactants that form a strong interfacial network are used to generate a stable oil in water nanoemulsion (or microemulsion) that does not coalesce. The peptide or protein surfactant also incorporates a mineralizing peptide sequence. In the presence of a silica source, this mineralizing component facilitates the formation of a silica shell to encapsulate the nanodroplet containing the active ingredient. The encapsulation process is very mild which should make it compatible for delicate actives such as proteins. Encapsulation efficiencies of >90% can be achieved.

The nanometer thickness of the silicate shell can be regulated which, in turn, allows the rate of active ingredient release to be controlled. A sustained release rate has been measured which can be controlled with the thickness of the silicate shell. Surface chemistry and texture can also be controlled to help optimise material characteristics.

Simple processes have been developed for the preparation of the protein surfactants which are used in much smaller quantities than traditional surfactants. Techno economic analysis has estimated the cost of producing silica nanocapsules using current established processes and workflows to be ~$5 per kg of nanocapsules.

Status & Access

Field trials for termite eradication are underway. Other applications are being lab tested

Contact us now to discuss licensing and collaborative research opportunities

1 2 3 4 5 6 7 8 9 Technology readiness level TRL = 5

People and Publications

Prof. Anton Middelberg

Biomolecular engineering research in vaccine engineering, biosurfactants and bio-inspired nanomaterials

Anton's work includes key projects to develop new technologies for cost-effective rapid vaccine development, sustainable biosurfactant technologies and nanomedicine approaches based on fundamental understanding of bio-nano interactions. One key research focus is work towards low-cost rapid-response nanovaccine manufacture.

His research into virus-like particle and nanoemulsion self-assembly has attracted more than $10million in research funding since 2003.

Selected Collaborations

Anton has worked closely with industry including Dow, Eli Lilly and Novartis. He also collaborates worldwide with the research community including Oxford and Cambridge Universities (UK), University of California Berkeley (US) and Tianjin University (CN)

Selected Accolades and publications

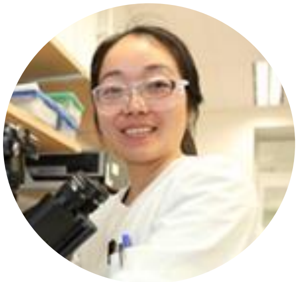
Anton has been named by Engineers Australia as one of the 100 most influential engineers in Australia and has been awarded the prestigious Queensland Premier's Fellowship.

Wibowo N, Chuan YP, Lua LHL, Middelberg APJ. (2013) Modular engineering of a microbially-produced viral capsomere vaccine for influenza. Chem Eng Sci 103, 12-20.

Chuan YP, Rivera-Hernandez T, Wibowo N, Connors NK, Wu Y, Hughes FK, Lua LHL, Middelberg APJ. (2013) Effects of pre-existing anti-carrier immunity and antigenic element multiplicity on efficacy of a modular virus-like particle vaccine. Biotechnol Bioeng 110(9), 2343-2351 (front cover).

Middelberg APJ, Rivera-Hernandez T, Wibowo N, Lua LHL, Fan YY, Magor G, Chang C, Chuan YP, Good MF, Batzloff MR. (2011) A microbial platform for rapid and low-cost virus-like particle and capsomere vaccines. Vaccine 29(41), 7154-7162.

http://www.aibn.uq.edu.au/anton-middelberg



Dr. Chun-Xia Zhao

Developing functional soft and hard materials through designing new biomolecules (peptides and proteins)

Chunxia leads the Green Chemical Engineering team within the Middelberg Group. She is focussed on developing new green platform technologies, including stimuli-responsive smart materials for making nanoemulsions; biomimetic synthesis of inorganic nanomatierials; and microfluidic synthesis of hierarchical materials for applications such as drug delivery and controlled release.

Selected Accolades and publications

Chun-Xia Zhao. Multiphase flow microfluidics for the production of single or multiple emulsions for drug delivery. Advanced Drug Delivery Reviews. 2013, 65: 1420-1446.

Chun-Xia Zhao, Lei Yu, Anton P.J. Middelberg. Magnetic mesoporous silica nanoparticles end-capped with hydroxyapatite for pH-responsive drug release. Journal of Materials Chemistry B. 2013, 1: 4828-4833.

Chun-Xia Zhao, Lizhong He, Shizhang Qi, Anton P.J. Middelberg. Nanoparticle synthesis in microreactors. Chemical Engineering Science, 2011, 66(7): 1463-1479.

Chun-Xia Zhao, Anton P.J. Middelberg. Two-phase microfluidic flows. Chemical Engineering Science, 2011, 66(7): 1394-1411.

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