DOI: 10.1017/S1431927605501740
Microsc Microanal 11(Suppl 2), 2005

Silica Nanospheres – A Novel Delivery System

M.G. Blackford,* C.A. Barbé,* K.S. Finnie*, L.N. Kong*, S. McNiven and Q. Lin

*Materials & Engineering Science, Australian Nuclear Science & Technology Organisation, Menai, New South Wales 2234, Australia

There has been considerable interest in developing novel particulate delivery systems for use in a wide range of controlled release applications. These include pharmaceutical (long term release, implants, patches, taste masking), food (flavors, scents, preservatives), agriculture (insecticides, herbicides, fertilizers), cosmetics and personal care (antiperspirant, soap, toothpaste, lipstick). Although a wide range of organic compounds have been used to manufacture these capsules or particles, very few inorganic controlled release systems have been commercialized. Ceramics in particular remain an untapped resource despite their numerous intrinsic advantages such as their resistance to corrosion, thermal and electrical stability, bio-compatibility and environmental friendliness. Hampering the use of ceramics has been the relative difficulty of manipulating their internal microstructure (compared with polymers) and their high processing temperature (incompatible with the encapsulation of organic molecules).

An innovative method allowing easy encapsulation of organic molecules inside micro and nanoparticles [1, 2] has been developed which overcomes both these limitations. Combining sol-gel technology [3], an inorganic, room temperature, polymerization technique, with water/oil emulsion synthesis enables a carrier to be produced in the form of mono-dispersed spherical particles, with an average size that can be varied from 20 nm to 100 μm (Fig. 1a and 1b). Particle diameter is determined by the size of the reverse micelles, which is controlled by the hydrophile-lipophile balance between the surfactant, aqueous phase and non-polar solvent. Release rate of the encapsulated species is controlled by the internal nanostructure of the spheres, which can be tailored by varying the sol-gel chemical parameters. The release rate can be independently varied from mg/hours to mg/month and is controlled by the internal microstructure of the particles.

This ability to independently control the release rate and particle size renders this technology particularly attractive for passive, *in-vivo* targeting of different organs and tumors. Biodistribution experiments were conducted to elucidate the *in vivo* pharmacokinetic characteristics of our nanoparticles (Fig. 1e). Modification of the nanoparticle surface by active molecules is being pursued to achieve active targeting of organs and tumors.

This technique has also been adapted to encapsulate complex shaped particles (Fig.1d), oils and proteins.

References

[1] C.J. Barbé, J.R Bartlett, *Patent*, PCT WO 01/62232, (2001).
[2] C.J. Barbé et al., *Adv. Mater*. 16 (No. 21) (2004) 1959.
[3] C.J. Brinker and G.W. Scherer, S*ol-Gel Science: The Physics and Chemistry of Sol-Gel Processing*, Academic Press 1990.

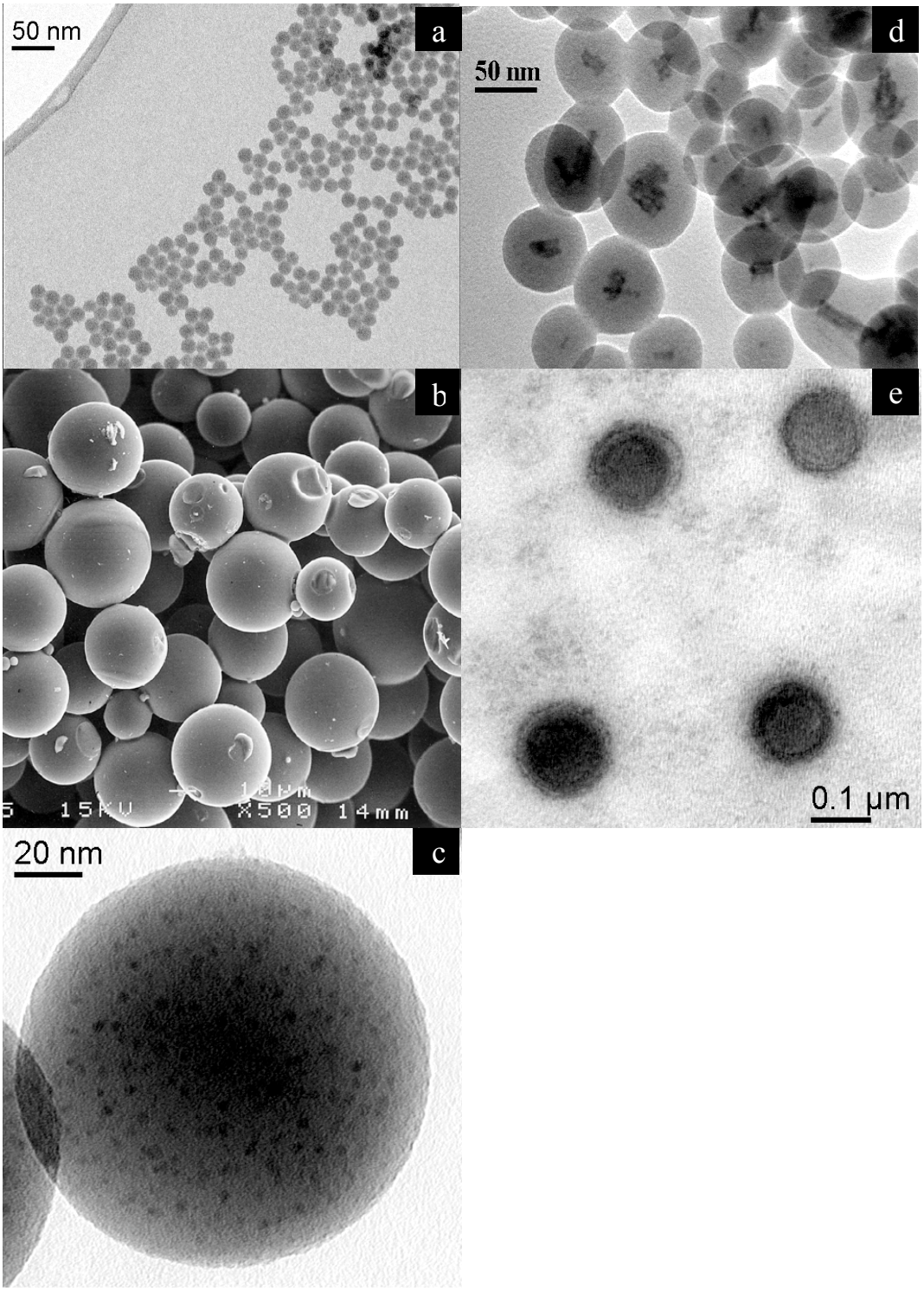

FIG. 1. Examples of amorphous silica nanospheres prepared via the sol-gel/microemulsion technique. a) Mono-dispersed 20nm diameter nanospheres. b) microspheres 20_m to 50_m in diameter. c) 120nm nanosphere with encapsulated copper particles. d) Nanospheres containing crystalline In_2O_3 cores. e) Microtomed section of mouse liver showing silica nanospheres lodged in tissue after biodistribution experiment.

https://doi.org/10.1017/S1431927605501740 Published online by Cambridge University Press