Comparison of two MCM-41 silica particles for the controlled release of semiochemicals

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Two nanoparticles, SNP1 and SNP2, were synthesized from tetraethyl orthosilicate (TEOS) in mild conditions of hydrolysis and condensation in the presence of hexadecyltrimethylammonium bromide (CTAB). The amount of CTAB used was ten times higher for SNP2 than for SNP1 synthesis. In the hydrolysis and condensation of TEOS, the influence of CTAB was shown by the kinetics of ethanol formation and by light scattering at 180 nm. The occurrence of a two-exponential process with observed rate constants of 2×10^{-2} min^{-1} and 6.7×10^{-9} min^{-1} showed that CTAB catalyzes the condensation of partially hydrolyzed CTAB molecules. Particles were morphologically characterized and also tested as releasers for [(Z)-hex-3-enyl] acetate (3ZHA) and (Z)-jasmone, two semiochemicals that are naturally biosynthesized by plants. Both particles have ordered hexagonal pores with similar sizes. The SNP1 nanomaterial presents very different internal (593 $m^2.g^{-1}$) and external (75 $m^2.g^{-1}$) areas whereas for the SNP2 those areas are of the same magnitude. Wall thickness is smaller for SNP2 than for SNP1. Morphological differences are reflected in the assay of the particles as releasers for the two semiochemicals. SNP1 showed almost quantitative loading of 3ZHA and 60% loading of (Z)-jasmone, with diffusion coefficient obeying the Fickian mechanism of diffusion for 3ZHA and anomalous transport for (Z)-jasmone[1]. For the SNP2 material, around 70% of the 3ZHA is incorporated and almost no (Z)-jasmone is loaded and thus no releasing is observed for (Z)-jasmone and for 3ZHA a mechanism of case II transport (diffusion and relaxation control) is verified. The different results obtained with the semiochemicals show that both the materials morphology and the structure of the incorporated molecule are important to design systems for volatile compounds releasing.

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Reference. 1. N.A. Peppas, J.J. Sahlin Int. J. Pharmac. 57(1989)169-172.