chemistry proceedings

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Abstract

Mesoporous Silica Nanoreservoirs Loaded with 1-H Benzotriazole for Active Anticorrosion Protection †

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† Presented at the 17th International Symposium "Priorities of Chemistry for a Sustainable Develop-ment" PRIOCHEM, Bucharest, Romania, 27–29 October 2021.

Abstract: In recent years, scientists are paying increased attention to the development of intelligent nanocontainers in applications such as biomedical, catalysis, and anticorrosion [1]. Preparation of anticorrosion coatings containing smart nanocontainers loaded with corrosion inhibitors, which can be initiated when the barrier coatings are damaged, favor the long-term function, as uncontrolled loss by leaching is inhibited [2]. The aim of the present study is to optimize the amount of an organic inhibitor (1-H benzotriazole (BTA)) that can be in situ encapsulated in a mesoporous silica nanocontainer, prepared by an original sol-gel formulation. **Materials and methods**: For the synthesis of silica mesoporous, nanoparticles loaded with BTA were used with three silica co-precursors: tetraethylorthosilicate (TEOS), phenyltriethoxysilane (PTES), and octyltriethoxysilane (OTES), at a 5/1/1 gravimetric ratio. The synthesis was carried out in the presence of a solvent (ethanol) and of a surfactant (Igepal CA-630). The pH of the sol–gel system was adjusted to ~9 by dripping an aqueous solution of NH_4OH (25%). Prior to the addition to the sol–gel reaction system, BTA was completely dissolved in ethanol. Various amounts of BTA were loaded to the sol–gel systems: 0.25; 0.5; 0.75; 1; 1.25; 1.5; and 2 g (corresponding to 0.09; 0.18; 0.27; 0.35; 0.44; 0.53; and 0.70% grav. of the total amount of sol–gel mixture, respectively). Furthermore, a similar set of samples was prepared in the presence of a constant amount of rhodamine B, dissolved in ethanol. This second set was obtained in order to perform a visual evaluation of the encapsulation efficiency. Particles dimensions, size distributions, and particles charging in the final dispersions were evaluated by the dynamic light scattering (DLS) technique and Zeta potential measurements. Surface morphology was observed by SEM. The structural characteristics of the silica mesoporous particles were investigated by N_2 adsorption–desorption analysis on the calcined samples. **Results**: During the in situ synthesis of silica nanoparticles, the aromatic molecules of the corrosion inhibitor BTA were linked via a hydrophobic interaction with the phenyl groups from the silica pores formed by the hydrophobic functions of silica co-precursors, i.e., PTES and OTES. In addition, the corrosion inhibitor was trapped inside the surfactant micelles of Igepal and encapsulated together inside the silica pores formed by the surfactant. Moreover, it was observed that only a small amount of BTA can be encapsulated in the absence of the surfactant. **Conclusions:** An optimized method was developed to obtain mesoporous silica nanoparticles loaded with 1-H Benzotriazole (BTA) as a corrosion inhibitor. The optimal range of the BTA concentration was found to be between 0.18 and 0.35%.

Keywords: anticorrosion protection; mesoporous silica; corrosion inhibitors

Citation: Nistor, C.L.; Burlacu, S.G.; Mihăescu, C.I.; Scomoroscenco, C.; Gîfu, I.C.; Ninciuleanu, C.M.; Ianchiş, R.; Petcu, C.; Alexandrescu, E. Mesoporous Silica Nanoreservoirs Loaded with 1-H Benzotriazole for Active Anticorrosion Protection. *Chem. Proc.* **2022**, *7*, 71. https://doi.org/10.3390/chemproc2022007071

Academic Editors: Mihaela Doni, Florin Oancea, Zina Vuluga and Radu Claudiu Fierăscu

Published: 6 May 2022

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Funding: This research was funded by a grant of the Ministry of Research, Innovation, and Digitization, CNCS/CCCDI–UEFISCDI, project number PN-III-P1-1.1-TE-2019-2053, within PNCDI III, contract no. TE 85/2020".

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

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