Gated Materials in Delivery Applications

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Abstract

Gated nanochemistry, although highly topical and rapidly developing, is still in its infancy. Recently some research groups have demonstrated the possible incorporation of “gates” into mesoporous supports. In this field, molecular or supramolecular gates can be defined as nanoscopic supramolecular-based devices in which mass transport can be triggered by a target external stimulus that can control the state of the gate; i.e., closed or open. A graphical representation of a gate-like superstructure is shown in Figure 1.

In fact in the last few years, nano-containers bearing gated scaffoldings have proved to be excellent candidates for the design of controlled-release “nano-machines” at different levels. For instance in the treatments of specific pathologies, e.g., cancer, highly toxic drugs have been used and a number of efforts have been made to design carriers to shield them until they are released at the target tissue or cell. However, the release mechanism of many current biodegradable polymer-based drug delivery systems simply relies on the hydrolysis-induced erosion of the carrier structure. To avoid this problem, the use of gated ensembles built up using silica mesoporous materials containing on-off triggered gate ensembles could be of importance. These systems show an ideal “zero release” until opened via a suitable stimulus. Mesoporous supports show stable structures (pores of ca. 2-3 nm), large surface areas (up to 1200 m^2/g), tunable pore sizes and volumes, and well-defined surface properties for site-specific delivery and for hosting molecules. The mesoporous support can additionally be obtained in a nanometric size, resulting in suitable materials for the design of “nanodevices” for the controlled delivery of drugs and other species. Moreover, a second more novel application involves the use of gated material in sensing protocols. In particular, very few works currently demonstrate the suitability of such objects for (bio)chemical sensing. In that case the concept involves designing capped materials capable of being opened in the presence of a target guest that triggers the delivery of a dye or fluorophore.

Examples of triggered gated materials able to deliver their cargo by changes in the pH,[1] temperature,[2] irradiation with light,[3] and by the presence of small molecules [4] or biomolecules [5] will be shown.

References

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Figures

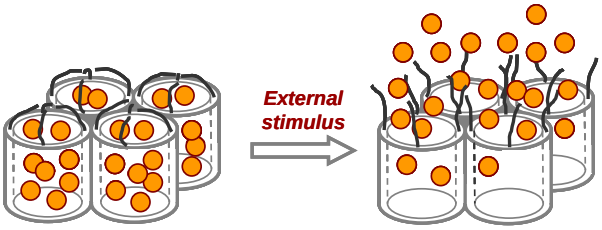

Figure 1*. A schematic representation of a gated material showing stimulus-controlled delivery*.