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Guests in Nanochannels of Zeolite L

Gion Calzaferri

Contents

Abstract Zeolite L (ZL) is a unique host. It accepts a large number of different guests inside of its nanochannels and allows specific modification of its surface. This is due to the combination of its chemical, structural, optical, and mechanical properties. The resulting composites have been investigated in a surprisingly broad field of applications, ranging from catalysis, lubricant technology, pigments, sensing, optics, optoelectronics, biology, drug delivery, diagnostics, and even human

G. Calzaferri (✉)
Department of Chemistry and Biochemistry, University of Bern, Bern, Switzerland
e-mail: gion.calzaferri@dcb.unibe.ch

medicine. ZL seems to be the only known thermally and mechanically stable material with linear channels of about 1 nm diameter, where the size of the particles and, hence, the length of the channels can be tuned in the range from about 30 nm up to 20,000 nm, which can be synthesized as crystals of different morphology such as discs, barrels, and elongated tubes. We discuss the synthesis of ZL, the many guests that have been inserted, the functionalization of the channel entrances with stopcocks and decoration of the coat, and different patterns created with ZL crystals. Much progress has been made in understanding the structure of guest-ZL composites. ZL has been used in catalysis and for creating artificial photonic antenna systems for light harvesting, transport, and trapping. The advances using ZL composites for diagnostics and for biological and biomedical applications are impressive. This remarkable evolution justifies to devote this article to zeolite L.

Keywords Breast cancer · Catalysis · Cluster · Diagnostics · Drug delivery · Dyes · FRET · Host-guest composites · Luminescence · Pigments · Rare earth · Sensing · Supramolecular chemistry · Zeolite

1 Introduction

The opportunities for creating nanochannel-based host-guest materials and for realizing organizational patterns with specific properties are immensely diverse [1–4]. Assemblies, polymers, crystals, and biological structures bearing nanochannels have been known and studied for decades [5–9]. Examples of nanochannel materials are cyclodextrins, urea-based assemblies, zeolites, zeotypes, mesoporous silica, collagens, organic nanochannels, carbon nanotubes, metal oxide nanochannels, and metal organic frameworks [5–15]. They have been investigated as hosts for molecules, complexes, ions, or clusters under a great variety of conditions. This gives a vague impression regarding the infinite number of combinations and hence objects with different properties that can be realized. Current research regarding such hosts and the resulting composites concerns catalysis, waste disposal, lubricants, pigments, sensing, optics, nonlinear and micro optics, electronics, optoelectronics, solar energy utilization, biology, cosmetics, sunscreen, drug delivery, diagnostics, and medicine. In these applications the chemical, structural, optical, and mechanical properties of the host are essential.

This article is dedicated to zeolite L as a host for guests comprising metal cations, metal clusters, metal complexes, organic cations, and neutral organic molecules. What is special about zeolite L? We show that the combination of chemical, structural, optical, and mechanical properties makes zeolite L – which we abbreviate as ZL, for simplicity – a unique host for creating distinct composites by accepting a large variety of guests and by allowing specific surface modification. Such composites have therefore been investigated in a surprisingly broad field of applications,