130a Molecular Size-Selective Vessel: Spherical Nano-Net

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A molecular-size cavity that possesses a functionalized interior, where chemical storage or transformation occurs is an essential component in many natural systems, such as an enzyme or a mineral zeolite. A cavity of this type, with a tunable size, enclosed by a porous, net-like shell of one- to two-atom layer thick and accessible by different molecules will have many potential applications such as reservoir for metal ions and molecules for targeted delivery, and as vessel for size-selective chemical and catalytic reactions. We describe a strategy to synthesize such a nano-net structure and demonstrate it with the synthesis of a 2 nm siloxane net with interior amine groups. The structure exhibits molecular size-selectivity, which is demonstrated using different-size chromophores such as ninhydrin and Zn porphyrin that are well-known probes to bind amine groups. The siloxane nano-net is also endowed with an ability to coordinate metal ions in the interior of the cavity. This feature is confirmed using exposure of nano-net to an aqueous Mo- or W-staining solution, followed by high resolution electron microscopy and energy dispersive X-ray analysis. The amine groups are chemically active, which is illustrated with the amine-catalyzed decomposition of acetoacetic acid to acetone and CO_2, and their catalytical properties are altered by the nano-net environment. The method can be readily adapted to nano-nets of different dimensions and for different interior functional groups.