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Aerogels made from Semiconductor Nanoparticles

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Nanoparticles are tiny structures with a diameter in the nanometer range that have become increasingly important in recent years due to their unique properties, such as a high surface-to-volume ratio. Semiconductor nanocrystals stand out in this regard because their band gap can be altered due to the quantum size effect, which enables the excitation of charge carriers by visible light. When these nanocrystals are assembled into hyperbranched structures, not only do they retain their special properties, but macroscopic monoliths with nanoscopic properties are also created. This also allows the surrounding liquid medium to be replaced and ultimately removed to form an air-permeable aerogel, making them attractive for future applications in catalysis and sensors. E.g. a solution of ligand-stabilized nanocrystals can be destabilized using an oxidizing agent, whereby this process slowly leads to the formation of a large, highly porous network with direct crystal-to-crystal contacts. The design of the nanocrystals and how they connect heavily influence the structure of the gel and its chemical properties. When a semiconductor-based hydrogel with water in the pores is exposed to radiation, charge carriers inside the nanocrystals can separate and move beyond a single building block, enhancing their ability to produce hydrogen as catalysts. Since the nanocrystals are fixed within the network, they cannot agglomerate any further, which improves catalytic efficiency. Several factors, such as the material composition, types of hole scavenging agents, and how the particles connect, influence the properties of these structures. [1] [2]

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[2] Anja Schlosser, Lea C. Meyer, Franziska Luebkemann, Jan F. Miethe, Nadja C. Bigall, Phys.Chem.Chem.Phys., 2019, 21, 9002

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