Silica-based particles with enhanced functionality for environmental protection

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In 2015, the 2030 Agenda for Sustainable Development was adopted by all United Nations Member States, serving as a shared blueprint for promoting peace and prosperity for people and the planet, both now and in the future. This initiative is centered the 17 Sustainable Development Goals (SDGs), including Goal 6: 'Ensure availability and sustainable management of water and sanitation for all' [1]. The need for effective treatment of both industrial and sewage wastewater has become an urgent and pressing task due to the growing concerns about water scarcity, environmental pollution, and public health issues.

In modern water treatment technology, there is a high demand for hybrid organic-inorganic nanostructured materials to be used as functional adsorbents. By understanding functional group anchoring at the molecular level and the sorption capacity of hybrid adsorbents with available functional moieties, it is possible to create adsorbents that exhibit high specificity and selectivity towards targeted pollutants. The focus of this study is to establish physicochemical principles for the one-stage production of silica microspheres and magnetically controlled carriers that have specific functional groups. The synthesis of these carriers is facilitated by the ease of sol preparation and composition control, the eco-friendliness of the alcohol by-products formed during the sol-gel transformations, and the advantageous properties of the final materials such as hydrolytic stability, resistance to acidic media, high sorption capacity, and the potential for regeneration.

Multifunctional adsorbents with several specific and non-specific adsorption centers deserve special attention. Materials with bi- or multifunctional surface layers have additional benefits. Spherical materials with different surface groups exhibit diverse types of interactions, such as coordination, ion exchange, hydrophobic, donor-acceptor, and intermolecular interactions. This diversity of surface interactions enables the efficient purification of water from heavy metals [2-4], organic pollutants [5,6], and bacteria [7] using these materials.

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References

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