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Titanium Dioxide Hybrid Ion Exchange Resin for Simultaneously Removing Arsenic & Nitrate

Ion exchange is widely used within industry and public infrastructure to remove metallic, organic, or inorganic particles from water. Ion exchange filters contain activated carbon or spongy polymer beads, called resin, which have been tailored to remove a specific group of contaminants with similar chemistry. Hybrid ion exchange resins are capable of simultaneously removing multiple contaminant groups. Currently, the only hybrid ion exchange resins are infused with iron oxide to remove groups containing arsenic and nitrate, two chemically distinct carcinogenic pollutants that are commonly found in pesticide and fertilizer runoff. However, iron oxide lacks chemical stability in lower pH water, which shortens its lifespan and restricts its capacity to absorb contaminants.

Researchers at ASU have developed a fast and inexpensive method of synthesizing hybrid ion exchange resins infused with titanium dioxide (TiO_2) nanoparticles that are robust for low pH water. In order to generate the nanoparticles, microwaves are applied to commercially available resins that have been submersed in water softened with inexpensive titanium precursor. The microwaves accelerate the reaction to 5 minutes at 100°C, but the TiO_2 nanoparticles can also be synthesized by 24 hour hydrolysis at 80°C. This fabrication process is very simple, it can be applied to any ion-exchange or carbon-based sorbent resin and zirconium dioxide (ZrO_2) can even be substituted for TiO_2. Ashing the resin then produces TiO_2 or ZrO_2 media that can be used as a photocatalyst or an antimicrobial coating. This method cuts costs by saving time, material, and energy, and is readily adaptable for large scale manufacturing.

Potential Applications

- Antimicrobial Coatings
- Groundwater Decontamination
- Hybrid Ion Exchange Membranes
- Municipal Wastewater Treatment
- Photocatalysis

Benefits and Advantages

- Economical – Inexpensive titanium precursor provides more bang for your buck.
- Efficient – Microwaves save time and energy needed to create TiO_2 nanoparticles.
- Practical – Chemically stable in both high and low pH water.
- Versatile
  - Can be applied to any commercially available ion-exchange or activated carbon resin.

- Zirconium dioxide can be substituted for TiO2.
- Multiple heating options for the hydrolysis reaction.

For more information about the inventor(s) and their research, please see

Dr. Kiril Hristovski's directory webpage

Dr. Paul Westerhoff's directory webpage