Jožef Stefan Institute
Center for Technology Transfer and Innovation

TECHNOLOGY OFFER

THE NEW ERA OF HIGH EFFICIENT MICROREACTORS BASED ON PHOTOELECTROCATALYTIC PROCESS

Fields of use

Wastewater treatment, Gas treatment, Determination of chemical oxygen demand, Selective synthesis of organic molecules

Current state of technology

Developed to the level of experimental proof of concept, technology readiness level three (TRL 3)

Type of cooperation

Licence agreement and technical cooperation

Intellectual property

Patent applied for but not yet granted

Developed by

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More information about the invention

Summary

Researchers from the Jožef Stefan Institute have developed an inventive design of the TiO2 photoelectrocatalytic reactor. The invention enables cheaper fabrication and higher photocatalytic activity. We are looking for partners for licence agreement and for technical cooperation.

Description of the invention

The problem:

Slurry reactors have suspended TiO2 nanoparticles and therefore require separation and recycling of the TiO2 nanoparticles from the treated water, which is an expensive and time-consuming process.

The solution:

Much more simple and cost-effective operation can be achieved with continuous flow photoelectrocatalytic reactors with immobilized photocatalyst. Such a device exhibit two primary advantages: there is no post separation of the photocatalyst needed and photocatalytic activity is significantly enhanced by the application of the external electrical potential. Another important advantage is that scale-up can be replaced by numbering-up of the microreactor device, which is previously optimized on laboratory scale to meet industrial needs. In this way, capacity of microreactor system for water treatment is simply magnified by adding additional units to the existing system.

The innovation provides a reactor made of a housing with a cylindrical chamber and an inlet and outlet channel. Within the chamber is a glass rod with photoanode coil and metallic cathode coils wrapped around it. Photoanode is made of anodized titanium coil and is illuminated by UV light from top and the bottom in a way all the surface of the titania nanotubes is reached by the light.

The main innovation of the photoelectrocatalytic device is in its design. One of the important differences from known reactors is in the relation between the active unit and the chamber. In the case of the present invention the active unit is positioned within the chamber but is not integral with it. This means that the housing and the active unit can be made separately which saves time and cost of the fabrication and also allows the replacement of the active unit alone if it is needed.

The researchers have confirmed the concept with very efficient degradation of two model degradation molecules: phenol and caffeine. The photoelectrocatalytic device fully mineralize both chemicals at high flow rates for a microreactor. The device was also scaled-up and tested for a longer time of operation to determine possible aging of the active unit. There is no significant change in its activity.

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The inventors are internationally recognized experts in the area of nanostructured materials focused on inorganic materials with specific physical properties that are a consequence of their structural and chemical phenomena at the nanostructural and atomic levels. Their fields of research involve natural and manufactured ceramic materials as well as metals and intermetallic compounds. In the past few years they have focused on development and characterization of photocatalytic and photoelectrocatalytic microreactors for use in water purification. They have developed three different reactor designs, from the most basic described in the scientific paper entitled "Highly efficient TiO2-based microreactor for photocatalytic applications" (Krivec et al., 2013) to the most simple and effective described in this document.

Jožef Stefan Institute has reached the 37th position on the European Research Ranking amongst the most successful European research organizations for the year 2014.

Main Advantages

- High photocatalytic surface-to-volume ratio enables very fast, continuous oxidation of organics.
- Cheap and fast fabrication; all the components are made separately and in the end assembled into the final device.
- Photocatalytically active anode coil constitutes of rigidly attached titania nanotubes that are grown by industrially known anodic oxidation process.
- There is no need for post-separation and recovery of the photocatalyst as it is immobilized.
- Photoelectrocatalytic device can be easily scaled-out, scaled-up, or numbered-up.
- Device can be optimized in a research laboratory for a specific use.
- Low treatment cost compared to other advanced oxidation processes; electricity consumption during the operation is low and can be supplied from the renewable sources.
- No addition of harmful chemicals and no harmful products, what makes the technology a green one.

Partner Sought

We are looking for industrial partners preferably providers of solutions for wastewater and sewage treatment, air treatment, determination of chemical oxygen demand or synthesis of organic molecules.

Industrial partners should be able to further develop and apply the technology in their existing line of products or use the technology as a complementary system for the decommissioning of micro-pollutants. License agreement and agreements for technical cooperation are sought.