Institut "Jožef Stefan", Ljubljana, Slovenija

center za prenos tehnologij in inovacij
na Institutu "Jožef Stefan"

Licensing opportunity

Photoelectrocatalytic microreactor for wastewater treatment, gas treatment, determination of chemical oxygen demand, or selective synthesis of organic molecules

Field of use
Microengineering and nanoengineering
Cleaning Technology
Micro- and Nanotechnology
Industrial Water Treatment
Sludge Treatment / Disposal

Current state of technology
Stage of Development: Under development/lab tested

Patent status
Secret know how

Publication
TBA

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Background

A Slovenian research institute has developed an inventive design of the photoelectrocatalytic reactor for wastewater treatment, gas treatment, determination of chemical oxygen demand, or selective synthesis of organic molecules. The invention enables cheaper fabrication and higher photocatalytic activity. The research institute is looking for partners for license agreement and for technical cooperation.

Description of the Invention

Photoelectrocatalytic oxidation with titanium dioxide (TiO2) photocatalyst is considered to be a suitable choice for relatively cheap and efficient elimination of organic pollutants from a variety of media, such as wastewater, polluted groundwater, toxic industrial wastes, and polluted air. Furthermore, photoelectrocatalysis can be successfully applied as an efficient route for the selective synthesis of organics or determination of chemical oxygen demand.

Photocatalytic reactors can be classified based on the deployed state of the photocatalyst, i.e., suspended or attached. 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. Much more simple and cost-effective operation can be achieved with continuous flow photoelectrocatalytic reactors with an immobilized photocatalyst. Such a device exhibits 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 the microreactor system for water treatment is simply magnified by adding additional units to the existing system.

The present invention 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 difference 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

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time and cost of the fabrication and also allows the replacement of the active unit alone if it is needed.

Since the technology aims to reach its full potential in an industrial setting, industrial partners are sought, in the field of wastewater and sewage treatment and gas treatment, as these are fields in need of such a technology. Furthermore, determination of chemical oxygen demand or synthesis of organic molecules represent another possible fields where the technology finds use. License agreements and / or agreements for technical cooperation will enable the researchers to maintain their focus on the research behind the technology whereas up-scaling to industrial level will be carried out in the industrial partner's setting.

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, one of which is described in this document.

Main Advantages

Innovative design constitutes of semiconducting anode coil and metallic cathode coils wrapped around a glass rod and put into a channel in the plastic housing. The photoanode is illuminated from the top and the bottom by energy-efficient UV LED lights. The main advantages of the photoelectrocatalytic microreactor are:

- 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 titanium 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, which makes the technology a green one

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