Institut "Jožef Stefan", Ljubljana, Slovenija

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

Licensing opportunity

Real time measurement of radicals in industrial plasma devices for surface modification

Field of use
02002009 Machine Tools
02002015 Surface treatment (painting, galvano, polishing, CVD, ..)
03001001 Cleaning Technology
05003002 Optics
09003 Electronic measurement systems

Current state of technology
Stage of Development:
Available for demonstration

Patent status
Copyright
Exclusive Rights
Patent(s) applied for but not yet granted
Secret Know-how

Publication
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Background

A spin-out company of a Slovenian research institute is offering a device for real time control of stability and uniformity of treatment parameters in industrial plasma reactors. The company is looking for industrial users and manufacturers of plasma reactors for technical cooperation agreement.

Description of the Invention

Nowadays numerous industries (electronic, automobile, textile, medicine, packaging) use low pressure plasma technologies to achieve desired material modification. Examples include surface finish of polymer and composite components in order to obtain desired surface free energy, nanostructured surface and appropriate surface composition. In some cases, the key parameter controlling the quality of said surfaces and materials is the density of radicals, in particular neutral atoms. The ability for real time measuring of this parameter during the processing enables process optimization, which in turn leads to better quality of products. Although widely used in industry, plasma technologies are capricious due to the fact that the plasma parameters often drift without touching the reactor. The drift represents significant problems in electro and chemical industries where polymer or composite components are treated by plasma in order to obtain the desired surface finish. The drift is a natural consequence of the fact that the surface properties of treated materials as well as plasma-facing surfaces change upon treatment. The changed surface functionalities, the modified surface roughness, the deposits formed on surfaces and the thermal effects all cause a drift in the density of radicals and its non-uniformity in the processing chamber. Such a drift makes the processing unpredictable, so many users overtreat the components to be on the safe side. The overtreatment, however, often leads not only to the waste of time but also to the loss of optimal surface finish due to thermal instability of surface functionalities and loss of nanostructured surface on the expense of micro-roughness. A good example is surface functionalization of polymers which is theoretically accomplished in few seconds of plasma treatment but producers prefer minutes of treatment just because of the radical gradients inside the processing chamber. The only technique for compensation of the drift is based on optical absorption spectroscopy but this technique is not suitable for measuring gradients of atoms during the treatment so it has not been introduced to a massive production yet. The Slovenian spin-out company has developed a device (LOCS – Laser Optic Catalytic Sensor) that allows real-time measuring of the key plasma parameter (radical density). The LOCS is capable of detecting even minor changes of the radical density, both time and space resolved. Its sole limitation is the lower detection limit, which is about

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10^19/m^3. The detection limit of few percent of drifts of atom density during etching of organic materials is achieved and the response time is about a second which makes the innovative sensor applicable for example in microelectronics (for measuring atom density during etching of photoresist what typically lasts few minutes) and in etching of composite commutators (the treatment also lasts few minutes in batch process).

The LOCS device is already in use for demonstration purposes by a number of companies in the area of surface treatment.

The stakeholders of the Slovenian spin-out company are researchers that have academic experience and numerous references. In the last 10 years, they have submitted approximately 20 patent applications, most of which were granted (7 of them were granted through the EU or US patent office).

The Slovenian company is looking for manufacturers and/or industrial companies that are developing/using plasma reactors to pool resources for final development under technical cooperation agreement. Companies sought should already have experience with the use of industrial plasma treatment and have ambition to improve their existing plasma reactors. Possible applications are in all industrial sectors where plasma reactors are used in production.

Main Advantages

The main advantages of Laser Optic Catalytic Sensor (LOCS) over other neutral atom measuring techniques (primarily Two-Photon Absorption, Laser-Induced Fluorescence - TALIF) are:
- lower complexity of the device and ease of handling ("plug and measure");
- smaller size – fits a standard 19'' rack with 4U height;
- doesn't require any additional calibration and works in different plasma reactors;
- simple integration of the sensor on the existing plasma reactor – no expert knowledge is required;
- lower cost: an estimated market price for LOCS is € 25.000 as opposed to € 50.000 for TALIF.

In the case of functionalization and etching of products made from polymers or polymer composites the reactors are large enough that gradients of radical density are unavoidable. A typical reactor allows a treatment of several hundred components in a batch so it is advisable to use two or three sensors – one in the centre of the reactor and another close to the walls to monitor the radical's gradients that occur naturally. The benefit of the company using the sensor arises from reduced treatment time which is adjusted automatically according to the loss of radicals upon processing of materials and components with different surface properties.

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