Institut "Jožef Stefan" Ljubljana, Slovenija

LICENSING OPPORTUNITY

REAL TIME CONTROL OF LOW-PRESSURE PLASMA PROCESSING PARAMETERS

Fields of use

Technology Keywords: 01002012 Semiconductors 02002001 Cleaning (sandblasting, brushing) 02002015 Surface treatment (painting, galvano, polishing, CVD, ..) 02007014 Plastics, Polymers 03001001 Cleaning Technology

Current state of technology

Available for demonstration

Type of cooperation

Implementation and technical cooperation under licence or technical agreement

Intellectual property

TBA

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Summary

A spin-out company of Slovenian research institute has developed a device for real time control of stability and uniformity of treatment parameters in industrial plasma reactors suitable for surface functionalization, etching and sterilization of different materials. The company is looking for industrial users and manufacturers of plasma reactors for implementation and technical cooperation under licence or technical agreement.

Description of the invention

Nowadays numerous industries (electronic, automobile, textile, also medicine) 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, nano-structured surface and appropriate surface composition. The key parameter controlling the quality of said surfaces and materials is the density of radicals, in particularly 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 a nightmare 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 the drift in the density of radicals and its non-uniformity in the processing chamber. Such a drift makes the processing unpredictable, so many users over treat 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 solved the problem by adjustment of the key plasma parameter (radical density) simultaneously.

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The investment is co-financed by the Republic of Slovenia and the European Union under the European Regional Development Fund.

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The plasma reactor is equipped with a probe capable of real time measuring of atom density. Recently such a sensor - Laser Optic Catalytic Sensor (LOCS) - has been developed. Its operation has been demonstrated in a laboratory plasma reactor. The LOCS is capable of detecting even minor changes of the radical density, both time and space resolved. The detection limit of few percent of drifts of atom density during etching of organic materials is achieved and the response time of the LOCS is below a second what 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 stakeholders of the Slovenian spin-out company are researchers that have many academic experience and references. In the last 10 years, they have submitted approximately 20 patent applications, of which most of them were granted (7 of them were granted through the EU or US patent office). Possible partnerships: 1. Manufacturers of plasma reactors for cooperation under licence agreement are sought. 2. Industrial users for implementation and technical cooperation under technical agreement are sought. Possible applications are in all industrial sectors where plasma reactors are used in production. Partners with a goal to improve the efficiency of their existing plasma reactors are sought.

Main Advantages

The main advantages of 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 (approximately the size of a large handbag);
- doesn't require any calibration and works in different plasma reactors with a wide range of plasma parameters;
- 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 € 100.000 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 about 1000 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. The benefit will be at least € 10 per batch. Current reactors allow for about 30 batches per day, so the benefit is € 300 per day or about € 100.000 per year. The integration is straight forward so this cost is minimal. The investment is thus returned in less than one year.

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