Local Surface Modification And Patterning At Multiple Length Scales Using DBD Plasmas with Patterned Dielectric Insulators

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BACKGROUND

Current methods for plasma-based modification of material surfaces (e.g. modifying adhesion, surface chemistry, wettability, or depositing other materials) cannot deliver precise control over the location of treatment without extensive use of complex lithographic or photoresist masks. Dielectric barrier discharge (DBD) plasmas operating at atmospheric pressure can accomplish such control by creating random plasma filaments or "streamers" where surface treatment preferentially occurs. Unfortunately, spatially-random and intermittent formation of plasma filaments precludes precise user-defined patterning of surfaces. As such, DBD plasmas cannot be used for controlled and spatially-localized surface treatment. Controlling and regulating the formation of plasma filaments with complete precision would thus provide extensive cross-industry opportunities for plasma treatment of surfaces.

DESCRIPTION

Researchers at the University of California, Santa Barbara have developed an atmospheric-pressure DBD plasma system capable of locally modifying and patterning surfaces, from mm to sub-micron length scales, by incorporating topographically patterned dielectric insulators to enable maskless patterning and treatment of all surface types. Geometrically patterning the plasma electrode dielectric insulators enables virtually any pattern of plasma treatment and/or plasma-printing on a myriad of sample surfaces. This invention can also be combined with other plasma processes (e.g. plasma polymerization of an organic monomer, or deposition of an inorganic thin film) for localized deposition of functional materials. These treatments can be applied statically or on translating samples at scale, which offers additional advantages in manufacturing efficiency. Applications of plasma-based surface treatment are vast, providing opportunities to tune the adhesion, moisture resistance, wetting, optical properties, roughness, hardness, and chemistry of surfaces. This technology fundamentally enhances and extends the realm of plasma treatment, modification, and patterning of surfaces of all kinds - without the use of sample masks and lithographic patterns.

ADVANTAGES

▶ Unprecedented treatment specificity
▶ Ability to control local surface chemistry
▶ User-definable surface patterning and modification at multiple length scales from mm to sub-micron
▶ Applicable to virtually any surface (ceramics, polymers, metals, fabric, etc.)
▶ Easily combined with other plasma processes
▶ Operates at atmospheric pressure and allows for extendable to roll-to-roll processing
▶ Scalable to virtually any processing area desired

APPLICATIONS

▶ Textiles
▶ Composites and laminate materials
▶ Medical devices
▶ Microelectronics
▶ Chemical/biological sensor and microfluidic platforms
▶ Packaging technology
▶ 3D Printing

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OTHER INFORMATION

KEYWORDS
plasma, DBD plasma, surface modification, patterning, dielectric barrier discharge, plasma filaments, streamers, printing, deposition, plasma polymerization, surface chemistry

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▶ Optics and Photonics
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