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NANO CONGRESS 2018-Nanoengineered plasma polymer films for biomedical applications - Krasimir Vasilev, University of South Australia.

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This forward looking concise review describes recent advances in the field of nanoengineered plasma polymer films. These types of coatings are relevant in many fields of application and have gained substantial research and technological interest over the last decade. The review starts with an introduction of plasma polymerization as a technique for preparation for nanometer thin polymer-like coatings. This is followed by the examples of the use of nanoengineered plasma polymer coatings in applications relevant to biomedical devices. Applications in antibacterial coatings and drug delivery vehicles are discussed. Significant section of this paper is dedicated to cell guidance surfaces which have an extensive range of applications ranging from coatings for medical devices to research tools that can help unraveling complex biological questions and vehicles for the growing field of cell therapies. The vision of the authors about the future directions of the field have also been presented, including a section on novel oxazoline based coatings that carry great promise for advances in the biomaterial and biomedical fields.

Introduction

Plasmas, the forth state of matter, have intrigued, puzzled and fascinated humans for millennia. Plasmas are everywhere around us. Plasmas make 99 per cent of the visible universe. Plasma are the lightning, the auroras and the sun core. Plasmas can be wild and uncontrollable but when their energy is confined, they become useful tools in numerous applications. Processes such as plasma etching and deposition revolutionized the semiconductor industry and made possible production of high speed computer processors which we are all enjoying today. Several new applications of plasmas such as in plasma medicine and plasma nanoscience are currently a hot topic of research and hold promise to revolutionize many fields. Surface engineering has been an area where plasma processes made and continue making substantial impact. The capacity to preserve valuable bulk properties but to alter the properties at the surface contributes substantial added value to numerous products in fields ranging from medicine to membrane filtration and electronics. An important aspect of plasma processing is the deposition of organic thin films. In most cases the deposition of such films is carried out under low pressure in reaction chambers The origin of the field of plasma polymerization could be traced back to the work of Linder and Davies in the 1930s who were the first to report polymer deposits on electrodes However, purposeful deposition of organic films from plasma started in the 1960s with the work of Goodman and Yasuda , followed many others who have made and are still making significant contributions to this field. Plasma polymers are a unique class of materials. They differ from conventional polymer by their irregular structure which makes it difficult to identify repeating units. For this reason, it is often argued about the use of the term "polymer", many insisting on classification as "organic films deposited from plasma". Although the latter may be more appropriate, the term "plasma polymers" is widely used and this is how these coatings will be referred to in this article. Plasma polymer are typically highly crosslinked and if deposited under appropriate conditions can be resistant to many solvents. This makes them valuable in many industry and research applications. An important characteristic of plasma polymers is that they can be deposited on practically any type of substrate material. This compare plasma polymers favorably to other techniques for preparation of very thin coatings such as layer-by-layer (L-b-L) or self-assembled monolayers (SAMs) which require a specific substrate such as charged and metallic surfaces

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respectively

Conclusion and future perspectives

We believe that by now the reader has become not only aware but also inspired by the opportunities offed by plasma polymerzation and the field of “Nanoengineered Plasma Polymer Films” overall. The capacity to modify the outermost surface of any type of material and place desired properties such as chemical, physical, topographical, mechanical or bioactive is fascinating. Furthermore, plasma polymerization allows to preserve the bulk properties of the material while the process of surface modification is fast, one step and solvent free. Surfaces can be altered to be biocompatible or biorepelling, functional or inert, wettable or non-wettable to suit a particular application. In the field of medical technology nanoengineered coatings facilitated by plasma have an enormous potential. They can be placed on stents, hip and knee implants, hearth valves and many others. They can be used as vehicles in cell therapies and drug delivery. They can be used as antibacterial coatings, to enhance tissue integration, to control inflammation, or all of these together. These is no doubt that the field of nanoenginnered plasma polymer films will grow in the future. The number of creative approaches will also expand together with the member of potential applications. An area that has been little explored until now is the generation of stimuli responsive and smart coatings. The reason for this is that the chemical structure of plasma polymers is rather undefined and more difficult to control compared to these produced conventional polymerization. With the increased need for smart coatings and the growing number of researchers embracing plasma polymerization, it is of no doubt that imaginative approaches for direct deposition or/and by bringing in other techniques will be developed in a very near future. This will also be facilitated by revealing the complex processes occurring in the plasma and learning how to use them in our favor. When applications are concerned, an important property of plasma polymers that needs to be taken into consideration is the mechanical rigidity. This property is not trivial to measure with conventional indentation techniques since plasma polymers are usually thinner than 100 nm and often in the range of 10-20 nm. This requires the development of new techniques to measure very thin film mechanical properties, also needed in other coating methods. Collectively, nanoengineered plasma polymer coatings offer a great degree of flexibility to generate surface of a wide range of useful properties and in this way have an enormous potential to provide solution to many urgent needs in the biomedical field. However, the usefulness of these films in not limited to medical devices. Opportunities and need exist in a range of other exciting fields such as micro- and nano-fluidics and organic electronics.

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