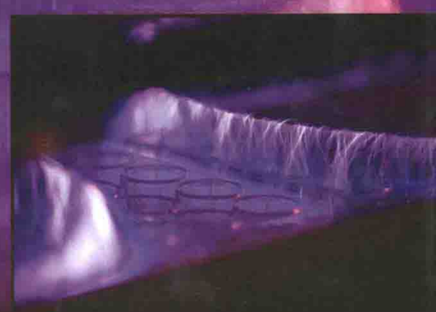
Adhesion and Adhesives:
Fundamental and Applied Aspects

Atmospheric Pressure Plasma Treatment of Polymers

Relevance to Adhesion



Edited by Michael Thomas and K.L. Mittal

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Atmospheric Pressure Plasma Treatment of Polymers

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Adhesion and Adhesives: Fundamental and Applied Aspects

The topics to be covered include, but not limited to, basic and theoretical aspects of adhesion; modeling of adhesion phenomena; mechanisms of adhesion; surface and interfacial analysis and characterization; unraveling of events at interfaces; characterization of interphases; adhesion of thin films and coatings; adhesion aspects in reinforced composites; formation, characterization and durability of adhesive joints; surface preparation methods; polymer surface modification; biological adhesion; particle adhesion; adhesion of metallized plastics; adhesion of diamond-like films; adhesion promoters; contact angle, wettability· and adhesion; superhydrophobicity and superhydrophilicity. With regards to adhesives, the Series will include, but not limited to, green adhesives; novel and high-performance adhesives; and medical adhesive applications.

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Preface

Polymeric materials are used for a legion of applications in a host of technological areas. However, polymers are innately hydrophobic, low surface energy materials and thus do not adhere well to other materials brought in contact. This necessitates their surface modification/treatment/activation to render them adhesionable. Apropos, surface modification is carried out not only to improve their adhesion characteristics but for a variety of other reasons too, for example to increase their hydrophilicity or hydrophobicity, to modify their tribological behavior, to render them flame resistant, etc.

A plethora of techniques (ranging from vacuum to atmospheric-pressure, wet to dry, simple to sophisticated, and inexpensive to sumptuous) have been employed to attain the required functional characteristics of polymers. Low-pressure (vacuum) plasma has been used for quite some time for polymer surface modification, but in the past decade there has been explosive growth of interest in atmospheric-pressure plasma (APP) processes because of their technological and economic advantages. They require no vacuum, need no expensive equipment, are easy to handle, can be used in a continuous mode, have a very good scalability, and can be simply integrated in existing process lines. Concomitantly, APP technology has been effectively utilized to treat polymers, paper, rubber, wool, fabrics, steel, glass and fiber-reinforced composites. Also, there has been much activity in ameliorating the existing processes, plasma sources and reactors or in devising new and improved ways to implement APP technology.

Besides plasma-based surface modification (activation, functionalization) using a number of gases, researchers have also been working on coating processes using atmospheric-pressure plasmas. Three different kinds of processes for coating deposition using atmospheric-pressure plasmas are being actively pursued. First is the grafting process where, after suitable plasma activation of the surface, the monomer is coupled on the surface using a subsequent wet-chemical step or gas-phase reaction. The second process is aerosol-based in which the precursor is directly sprayed into the plasma zone. The third kind of process is the plasma enhanced chemical vapor deposition (PECVD) in which a precursor, frequently together with a suitable process gas, is introduced into the discharge. It should be mentioned that besides the dielectric barrier discharge (DBD), other plasma sources (e.g., surface barrier discharge (SBD), coplanar barrier discharge (CBD), plasma jets, AC corona discharges, etc.) working at atmospheric pressure are of great interest.

Now coming to this book (containing 15 invited articles) it is divided into two parts:

Part 1: Fundamental Aspects and

Part 2: Adhesion Enhancement.

Topics covered include: combinatorial plasma-based surface modification of polymers; treatment of polymer surfaces with surface dielectric barrier discharge plasmas; selective substitution reactions on polymer surfaces by different plasmas; dielectric barrier discharge pretreatment of polymers in presence of aerosols; nanoscale surface structures on wool fabrics by atmospheric-pressure plasma treatment; nanosilica coatings on plasma activated polymers; biomedical applications of atmospheric plasma treatment of polymers; atmospheric-pressure plasma polymerization surface treatments for enhanced polymer-polymer and metal-polymer adhesion; functionalization and adhesion enhancement of various polymers using atmospheric pressure plasmas; atmospheric plasma treatment in extrusion coating; and enhancement of fracture toughness of adhesively bonded systems using atmospheric-pressure plasma treatment.

It should be recorded that all manuscripts were rigorously peer-reviewed, properly edited and suitably revised (some twice or thrice) before inclusion in this book.

This book representing the cumulative wisdom of a number of key researchers provides an overview and highlights the latest developments in APP technology. The book should be of much value to anyone interested in harnessing the potential of APP technology in enhancing adhesion in a variety of industries, namely printing, packaging, aerospace, automotive, composites, microelectronics, biological and biomedical, and others. As we delve further into the working of APP technology, new application vistas will emerge. This covers the large area treatment, e.g. internal coating of closed polymer bags or microfluidic devices and microplasmas for area-selective treatment of polymers. Moreover, treatment of skin for wound dressing is a very promising technology, which is under investigation and could be introduced into the market soon.

As a side comment, APP sources find their way into household applications. Kash Mittal has even heard that a company is planning to come up with an APP device for *in-situ* treatment of lips to enhance lipstick adhesion and of nails to enhance nail polish adhesion. What an interesting and exciting application!

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