DIFFUSE COPLANAR SURFACE BARRIER DISCHARGE AND ITS APPLICATIONS FOR IN-LINE PROCESSING OF LOW-ADDED-VALUE MATERIALS

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Abstract. The paper reviews a current state of the art in the in-line plasma treatment of low-cost materials and opportunities for the use of the so-called Diffuse Coplanar Surface Dielectric Barrier Discharge (DCSBD). A brief outline of physical mechanism and basic properties of DCSBD is given. The results presented on the ambient air plasma treatments of textile, paper, wood, and glass illustrate that DCSBD offers outstanding performance with extremely low energy consumption for large area, uniform surface modifications of materials under continuous process conditions.

1. INTRODUCTION

In recent years, low temperature atmospheric pressure plasma surface treatments (APPSTs) have become a hot topic because of the potential of fast and efficient in-line processing fabrication without expensive vacuum equipment [1, 2]. The potential economic and operation advantages of coating at 1 atm have led to the development of a variety of APPST reactors [1-4]. It is apparent, however, that only a very limited number of the APPST reactors discussed in the technical literature have proven practicable or economic for the intended in-line industrial applications.

A serious obstacle to commercializing the in-line APPST on a large industrial scale is the necessity to reduce the treating times to values less than 1 sec, which requires a plasma power density at least of the order of 10 W/cm^3. This is an uneasy task because increasing the deposited power density the plasma has the tendency of filamentation and to transition into a spark or arc discharge. As a consequence, a common theme of many atmospheric pressure plasma approaches is that a helium and occasionally argon containing working gas is required to prevent the plasma filamentation and sparking [5, 6]. However, the costs associated with using large amounts of helium or argon makes such APPSTs impractical to use in industries requiring high rates of throughput of low-cost materials, e.g., the textile and paper industries.

In an in-line processing at atmospheric pressure, it is very difficult to operate in a completely air-free plasma gas. This problem is particularly difficult when porous materials such as fabrics and paper are treated at high line speeds. Because of this and also because of the gas economy issue, in practice it turned out that "ambient air" is considered to be the ideal discharge atmosphere for most APPST applications. As a consequence, discussing the in-line surface plasma treatments of relatively low-cost materials we shall restrict ourselves to the plasma sources capable to generate highly non-equilibrium ambient air plasmas with the power density higher than the order of 1 W/cm^3.

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