



TRATAMENTO POR DBD PLASMA DE NITROGÊNIO PARA AUMENTAR A ADESÃO DE PISOS DE MADEIRA

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RESUMO: Tratamento por plasma caracteriza-se como eficiente e como uma alternativa econômica e limpa para modificar a superfície da madeira. O presente estudo objetivou aumentar a adesão de peças de piso de madeira por plasma a frio. Para o tratamento dos pisos de madeira, utilizou-se um reator a plasma admitindo-se uma mistura de argônio e nitrogênio entre os eletrodos durante 10 minutos em baixa pressão. Configurou-se o reator para três níveis de potência – 50, 100 e 150 W e uma frequência de 13.5 MHz. O fluxo de gás de argônio e nitrogênio foi estipulado em 10 e 100 sccm, respectivamente. As modificações na adesão foram investigados por meio de um goniômetro para a mensuração do ângulo de contato e a energia livre superficial. Para cada amostra, três gotículas (9.6 µl) foram dispensadas na superfície da madeira. Os principais resultados encontrados mostraram que o ângulo de contato das amostras modificadas por plasma foram ~2 vezes menor em relação ao ângulo de contato mensurado nas amostras não tratadas. A energia livre superficial da madeira modificada por plasma aumentou significativamente. O ângulo de contato e a energia livre superficial das amostras tratadas em diferentes potências foram estatisticamente iguais. Portanto, os tratamentos de plasma modificou significativamente a superfície da madeira em diferentes níveis de potência, o que resultou no aumento da adesão.

Palavras Chave: molhabilidade, energia superficial, tratamento de superfície, plasma a frio.

NITROGEN DBD PLASMA TREATMENT TO ENHANCE ADHESION OF WOOD FLOORING

ABSTRACT: Plasma treatment is characterised as efficient, clean and economic alternative to modify wood surface. This study aimed to increase adhesion of wood flooring using cold plasma surface treatment. Cold plasma reactor was used and a mixture of argon and nitrogen was admitted between the electrodes for 10 minutes at reduced pressure to treat wood flooring surfaces. Three levels of power – 50, 100 and 150 W – and 13.5 MHz frequency were used. Mass flow of argon and nitrogen was set to 10 and 100 sccm, respectively. Changes on adhesion were investigated using a goniometer to measure the contact angle and the surface energy. Three droplets (9.6 µl) per sample were disposed on wood surface. The main findings showed that contact angle of treated samples was ~2 times lower than contact angle measured in untreated samples. Surface free energy of wood modified samples increased significantly. Contact angle and surface free energy of wood samples treated with different values of power was statistically equal. Therefore, plasma treatments significantly changed the wood surface for all the power applied, which resulted in an increase of adhesion.

Keywords: wettability, surface energy, surface treatment, cold plasma.

1. INTRODUCTION

Wood is widely required by building sector and for aesthetic uses, which result, in most of the cases, in products with high value-added. Nevertheless, some of these products present limitations related to the adhesion of surface in their processing due to natural characteristics such as presence of extractives. Therefore, finishing process with the application of chemical products and coating films cannot present a desirable behaviour. Likewise, according to Jie-Rong et al. (1999), process such as printing, adhesion, spray and dyeing are highly related to the surface wettability of polymeric materials.

New techniques have been developed to use wood and wood-based products in better conditions. Among these techniques, impregnation and deposition of eco-friendly liquid or gaseous substances from natural or synthetic sources, such as enzymatic and plasma treatments should be emphasized.

One of the most promise alternatives is the plasma treatment, which presents recent studies about their advantages for modification of materials' surface using different types of gases. Utilisation of plasma enables the modification of surface properties of polymers, such as wettability and adhesion, without changes in bulk properties of the material (PODGORSKI et al., 2000).

Performance of plasma occurs in the surface of materials, in which the main objective is the modification of chemical and physical properties (INAGAKI, 1996). Surface changes depend on some factors such as substrate composition and gas used, which can be nitrogen, argon, helium, methane and ammonia (FINSON et al. 1995). On the other hand, improvement of plasma treatment can be performed modifying parameters of process such as pressure, time of discharge and gas flow (ROSSEL, 2007). Plasma treatment can be performed in two ways: at reduced pressure or at atmospheric pressure (BOENIG, 1982; UEHARA, 1999; KOGELSCHATZ, 2003).

According to Sarmadi et al. (1995), cold plasma presents many advantages, such as most of phenolic volatile compounds can be used as monomeric material; process of coating can be performed in only one-step of reaction; only a small quantity of material is necessary to implementation of the technique; and not present a high-energy consumption.

Plasma treatment is one of the most interesting and promising technique in forestry sector for modification the properties of wood fibres used for production of composites (LIU et al., 2010; HAN et al., 2011; MOGHADAMZADEH et al., 2011). Furthermore, can be used as protective layer in solid wood pieces and to improve many characteristics, such as adhesion and dimensional stability (ACDA et al., 2012; JAMALI and EVANS, 2011; MAGALHÃES and SOUZA, 2002), mainly when structural properties of the material are desirables. Therefore, plasma treatment is feasible when the main objective is improve the properties related to wettability and adhesion of surface of solid wood and wood-based products (PODGORSKI et al., 2000; REHN et al., 2003; ACDA et al., 2012).

In this context, the present study aimed to increase the surface adhesion of *Dialium guianense* solid wood flooring using cold plasma treatment (nitrogen DBD treatment).

2. MATERIAL AND METHODS

Material used in this study was collected in a Brazilian wood flooring industry. Samples of *Dialium guianense* (tamarindo) solid wood flooring measuring 2.5 x 2.5 x 10 cm were prepared and dried at 103°C in an oven without force air circulation to obtain moisture content of ~0%, which was the initial point of the plasma treatments.

Plasma treatments were performed in a cylindrical stainless reactor (Figure 1) developed in Embrapa Forestry. The reactor is equipped with a vacuum system and a butterfly valve for controlling the level of pressure inside the chamber; a capacitance manometer performs determination of this pressure. Dielectric barrier discharge (DBD) is performed using a system of capacitive stainless plates measuring 30 cm diameter, which is connected to a system of power generation at high frequency (13.5 MHz). Admission of gases is controlled