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Durability of polyamide bonded joints: influence of surface pre-treatment

C. Mandolino*, E. Lertora, C. Gambaro, M. Pizzorni

University of Genoa, Polytechnic School, Department of Mechanical Engineering,
Via All' Opera Pia 15, 16145 Genoa, Italy, chiara.mandolino@unige.it, e.lertora@unige.it,
gambaro@diptem.unige.it, marco.pizzorni@dime.unige.it.

*Corresponding author: chiara.mandolino@unige.it, tel. +390103532970, fax. +39010317750.
Address: Via All' Opera Pia 15, 16145 Genoa, Italy

Abstract

The aim of this study was to evaluate the influence of surface pre-treatment on the durability of bonded joints between polyamide pieces. Various surface preparations of the substrates were carried out and a wedge test was performed to evaluate the joint behaviour over time. Joints composed of polyamide 6 and polyamide 66 were made using a two-component acrylic adhesive. Four different surface treatments were compared: only degreasing, degreasing + abrasion, degreasing + plasma and degreasing + abrasion + plasma. The tests carried out highlighted the extreme importance of choosing the right surface preparation if one wishes to guarantee high performance over time. For both substrates, superficial preparations with cold plasma yielded the best results.

Keywords: surface treatment; ageing; wedge tests; cold plasma; polyamide.

1. Introduction

In recent years, numerous studies have been carried out to understand the behaviour over time of polymer materials used in industrial applications. Indeed, the use of polymers instead of metal materials and adhesives instead of welding have become increasingly widespread as they allow one to obtain lightweight and corrosion-resistant structures, as reported by Ebnesajjad [1] and Petrie [2]. However, it is of the utmost importance to determine the joint behaviour over time, since adhesives, just as polymeric materials in general, have physical and mechanical properties that tend to deteriorate due to temperature and humidity variations. A study on this was carried out by Lertora et al. [3] on methacrylate adhesives for naval use.

As reported by Ebnesajjad [4], adhesive strength decreases more rapidly in an aqueous-vapour environment than in water immersion because vapour has a much more rapid infiltration. The interface represents the most delicate and important point in the system and often the surface treatments tend to delay adhesive strength degradation in moist environments.

On the other hand, environmental effects on adhesive joints are enhanced by stress. Few data are available on the simultaneous effect of ageing and stress, however, because long lasting and expensive tests have to be used. Nevertheless, it is recognised, that a moisture environment significantly decreases the ability of an adhesive to tolerate prolonged stress.

In the literature, studies can be found on the ageing behaviour of adhesives such as in the works of Ocana et al. [5] and LaPlante et al. [6] and bonded joints between parts made of aluminium, steel [7], epoxy matrix composite [8], [9], glass [10], or wood [11]. For example, in Korta et al. [7] the effects of severe environmental conditions on the shear and tensile strength of homogeneous and heterogeneous bonded joints are described. The results of the FEM simulation presented in the same article show that the deterioration of joint performance is due both to the diffusion of moisture between the adhesive interface and the substrates and to the high internal stresses that are generated due to the different thermal expansion of the contact materials.

Machalicka and Eliasova [10] studied the effect of artificial ageing on different substrate and adhesive types, with various geometric configurations of joints undergoing shear and tensile

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