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Block copolymers for corrosion protection of aluminium

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Abstract

In this work, poly(*n*-butyl acrylate-*b*-trifluoroethyl methacrylate) (PBA-*b*-PTFEMA) and poly(*n*-butyl acrylate-*b*-heptadecafluorodecyl methacrylate) (PBA-*b*-PHFEMA) diblock copolymers synthesized by controlled radical polymerisation are used as a monolayer to protect aluminium against corrosion.

Contact angle measurements show hydrophobic behaviour that can be attributed to the presence of a fluorinated block. The preferential orientation of the fluorinated block at the coating/air interface can explain the high hydrophobicity behaviour. Finally, corrosion resistance has been investigated by Electrochemical Impedance Spectroscopy (EIS). The results show that the PBA-*b*-PHFEMA copolymer provides excellent anti-corrosion barrier properties, even after 60 days of immersion in a solution of 3% NaCl. ***To cite this article: V. Roche et al., C. R. Chimie 11 (2008).***

Résumé

Des copolymères à blocs poly(acrylate de *n*-butyl-*b*-méthacrylate trifluoroéthyle) (PBA-*b*-PTFEMA) et poly(acrylate de *n*-butyl-*b*-méthacrylate d'heptadécafluorodécyle) (PBA-*b*-PHFEMA) ont été synthétisés par polymérisation radicalaire contrôlée. Ces polymères ont été par la suite appliqués en revêtement monocouche afin de protéger l'aluminium contre la corrosion. La morphologie des revêtements obtenus a été caractérisée par microscopie à force atomique (AFM). Par la suite, leur caractère hydrophobe, dû à la présence du bloc fluoré, a été mis en évidence par mesures d'angles de contact. Les résultats ont montré l'orientation préférentielle du bloc fluoré à l'interface revêtement/air, expliquant leur caractère fortement hydrophobe. Enfin, leur résistance à la corrosion a été étudiée par spectroscopie d'impédance électrochimique (SIE). Il en ressort que le copolymère PBA-*b*-PHFEMA présente d'excellentes propriétés de barrière anticorrosion, même après 60 jours d'immersion dans une solution de NaCl 3%. ***Pour citer cet article : V. Roche et al., C. R. Chimie 11 (2008).***

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1. Introduction

Most of the time, protection of metallic substrates (e.g., aluminium, steel, galvanised steel…) against corrosion by organic coatings involves multilayer systems. These systems include at least three painting layers of different types: the primary layer – directly applied on the substrate – confers a good adhesion on the system of painting, an intermediate layer, which generally provides the thickness of the coating and its barrier function, and finally, the topcoat to protect all the underlying layers. This layer often brings the esthetical aspect. Each painting layer is usually formulated from five constituents [1–4]: the binder matrix (usual binders are epoxy, polyurethane or alkyde), inorganic or metallic pigments, extenders, additives for specific properties (anti-foamers, fire retarding agents, anti-coalescence agents, UV-absorbers…) and solvents (to reduce the viscosity of the coating and to control the drying).

The major disadvantage of the use of these three coat-painting systems is related to the coating process (time and cost). In order to simplify the sequence, the key step is to elaborate a single layer (unilayer system) gathering all properties of a three-layer-based system. To reach this objective, various properties of polymers (low water permeability, good mechanical properties…) have been combined using diblock copolymer as a monocomponent system (Fig. 1).

In a diblock copolymer, the two segments are covalently bonded [5]. The presence of covalent bonds between the blocks definitely improves the mutual miscibility of the two polymers. Thus, a nanoscale self-organization can be easily achieved for such

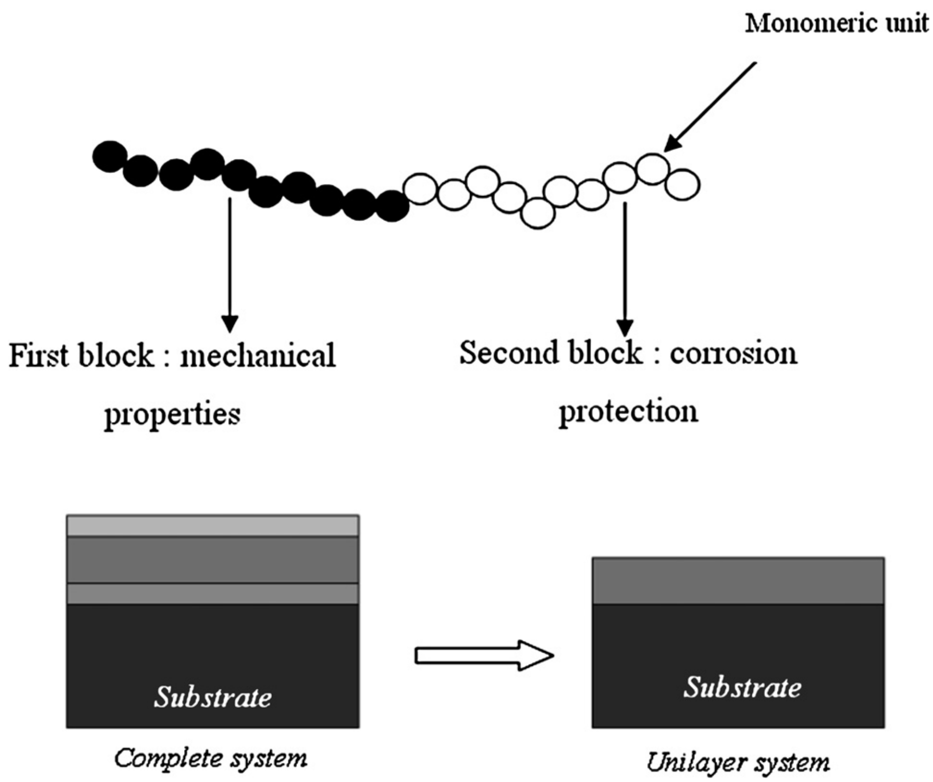

Fig. 1. Schematic representations of a block copolymer and a system of paintings.