Morphological characterization of ABS and PC-ABS surfaces for automotive industry

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Reception date of the manuscript: dd/mm/aaaa
Acceptance date of the manuscript: dd/mm/aaaa
Publication date: dd/mm/aaaa

Abstract—In the automotive industry, the measurement, control and reproducibility of certain morphological characteristics of surfaces are important to characterize, qualify, certify and optimize different physical properties, such as the degree of wear, the degree of adhesion by adhesives, glues or paints and optical properties. In this regard, this work wants to demonstrate how it is possible to characterize different surfaces in ABS (Acrylonitrile Butadiene Styrene) and PC-ABS (PolyCarbonate/Acrylonitrile Butadiene Styrene) material through a new set of morphological parameters defined according to the ISO 25178 standard. These particular surfaces have been subjected to different etching treatments performed with different chemical elements: these treatments can radically modify the morphology of the surface, making it more or less suitable according to the industrial purposes sought. At the end of the paper, the correlation between the *Sdq* and *Sdr* parameter for this type of surfaces will be studied and a theoretical relationship between this morphological parameters will also be proposed. This study is based on the use of a DCM8 confocal optical microscope and a SEM (Scanning Electron Microscope), which allow to obtain surface morphological information on a micrometric and nanometric scale and the measurements obtained are analyzed with special imaging and three-dimensional scanning software that allow the precise measurement of morphological parameters of the standard ISO-25178.

Keywords— ISO-25178, ABS, PC-ABS, Beckmann distribution, morphological parameters, *Sdq* and *Sdr* correlation.

I. Introduction

In recent years, the development of a method to study textured surfaces has been essential as it can explain a large number of physical properties often required for industrial purposes, such as anti-corrosive, hydrophobic, hydrophilic and anti-freeze properties [1–4]. A precise surface characterization is increasingly required in many industrial fields, from aerospace to photovoltaic industry, making a morphological characterization method indispensable [5, 6]. Even the optical properties of a surface can strongly depend on the morphology: the perceived optical effect, which is often described in the literature through the BRDF (Bidirectional Reflectance Distribution Function), is influenced by the distribution of the normal unit vectors of the surface itself, as well as by its morphology [7–15].
The ISO 25178 standard series of the Geometrical Product Specifications (GPS) system proposes a structured method for the characterization of the surface texture. In this standard, many morphological parameters are defined. These parameters describe particular characteristics of a surface and are calculated on the morphology measured through contact and non-contact instruments. This standard also defines several morphological filters, defined in the wavelength space, which through the calculation of the Fourier transform allow for example to remove measurement errors that arise during the surface acquisition of the studied sample.
In this work several results about a restricted number of these parameters will be shown, studied and described: these parameters are able to provide a precise description of the surface morphology and through them it will be shown how it is possible to characterize a surface for many practical industrial aspects.
The main purpose of this work is to show how it is possible to qualify ABS and PC-ABS surfaces through the ISO 25178 standard. In this paper, surfaces in ABS and PC-ABS material etched through chemical baths based on hexavalent chromium are studied. In many industrial application fields, etching baths are based on this particular chemical element but several technologies have been advanced to avoid using hexavalent chromium. Therefore, this article also shows the morphological differences of surfaces etched through hexavalent chromium or through other chemical elements. The main parameter that in this work characterizes the process of etching is the time of immersion: the main morphological differences as a function of the time of immersion will