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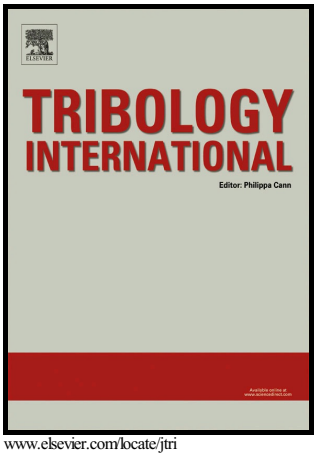

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Experimental bench for studying the relation between the dynamic characteristics of the frictional motion and the electric potential at the surface of polymer slabs in sliding conformal contact

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Abstract
Quantifying the triboelectric charging that occurs at polymer-on-polymer contact is crucial in the appropriate design of sliding or rolling components of various mechanisms . The paper describes the key devices and instrumentation of a laboratory bench developed for the accurate study of the tribocharging characteristics of polymer slabs in frictional sliding conformal contact. The bench enables the adjustment of several factors that affect the electrostatic charge generation (relative sliding speed, normal contact force, and number of back-and-forth cycles), and is equipped with sensors for the continuous monitoring of sample displacement, as well as of both normal and tangential forces. The triboelectric charge is evaluated by non-contact 2-D mapping of the electric potential at the surface of the samples at the end of the frictional process. The experimental methodology includes appropriate filtering of the signals provided by the sensors, before being recorded and interpreted. The cartography of the surface potential is put in relation with the dynamic characteristics of the frictional motion. The effectiveness of the laboratory bench is illustrated by the study of the electric potential generated by frictional sliding conformal contact between rectangular slabs of Polyvinyl Chloride (PVC) and Acrylonitrile Butadiene Styrene (ABS).

Keywords: triboelectric effect, sliding conformal-contact, test-bench, polymers, condition monitoring, signal processing, electrostatic charge

1. Introduction

The triboelectric effect, which is also designated as triboelectric charging or tribocharging, consists in the redistribution of electric charge carriers at the contact and separation of two bodies [1-4]. This effect has been successfully employed for the electrostatic separation of tribocharged granular materials [5-8] and for energy harvesting [9,10]. It has been intensively studied in relation with the risks associated to static electricity build-up [11]. Thus, an electric charge, a spark, can occur whenever tribocharged bodies approach other objects that are either conductive or carrying a charge of opposite polarity. The electric sparks can ignite flammable vapors or dust clouds, initiate explosions, damage or disturb the electronic circuits [12,13].

Polymers are frequently selected as sliding or rolling components of various mechanical machines and devices due to good mechanical properties and self-lubricating conditions. Many studies are aimed to better understanding their behavior but the triboelectric effect generated by sliding or rolling between different parts is only seldom taken in the consideration [14-20]. Nevertheless, understanding and quantifying the triboelectric charging that occurs at polymer-on-polymer contact is crucial in the appropriate design of such equipment [21-25].

The experiments described in the literature indicate that the triboelectric effect depends on a multitude of interacting factors, including friction type, temperature, and relative humidity [26-31]. Some results are contradictory, as discussed by Castle [2], who also pointed out the