

STUDY OF TRIBOFILM FORMATION IN A SLIDING ELECTRICAL CONTACT:
CORRELATION WITH WEAR AND ELECTRICAL PERFORMANCE

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ABSTRACT

Recent interest in improving lifespan of electrical slip rings for application in wind turbines has renewed the need for deeper understanding of sliding electrical contact operation. In contact slip rings using graphite-based brush technology, the creation of a tribofilm, or “patina”, at the interface with the metal slip ring is a well-known phenomenon [1], [2]. In this scope, the study of its formation in a bronze/silver-graphite contact has been conducted. The test bench is based on an instrumented industrial slip ring specific for wind turbine application. It permits to measure the electrical performance of the contact during the rotation. The electrical resistance measurement, coupled with an encoder for the angular position, allows to draw the electrical resistance as a function of both the number of cycles and the position of the brush on the ring. Thanks to this, we are able to link the electrical performance to the structural and chemical state of the tribofilm. We performed surface and structural observations with optical microscope and SEM/TEM/EDX, as well as advanced chemical surface characterization with XPS and Raman spectroscopy. Thanks to this multi-technical analysis, a scenario of tribofilm formation on the metallic surface of the slip ring has been proposed, and permits to justify the evolution of the electrical performance of the sliding contact (Figure 2). Wear measurements on the silver-graphite brushes were also conducted. The results show an influence of both the electrical current direction and the brushes sliding direction on wear. If the polarity effects were already documented in the literature [3]–[5] and can be explained by oxidation phenomena, the effect of the sliding direction seems to be more peculiar. We suspect the loose third body, composed by powdery wear debris, to be responsible for the reduction of the brush wear. It could explain why the effect of sliding direction is not well described, since it would depend on the contact geometry and its debris retention capability. Further investigation will be undertaken to confirm this hypothesis. We also want to estimate the impact of a modification of the roughness of the metallic ring, which could

play a role in the debris retention and the tribofilm formation.

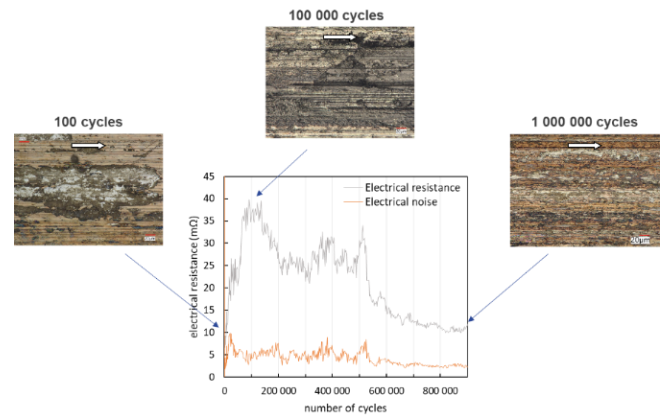


Fig.1 Evolution of the electrical performance of the contact (electrical resistance and noise) during the test. Optical micrographs show the state of the tribofilm on the metal ring

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