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Bichromatic measurement of thermal fields induced by friction

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Introduction

During braking two types of phenomena, thermal and tribological, are observable. The dissipation of kinetic energy at the contact interface leads to thermo mechanical deformation of the disc, that causes the formation of a hot band. The wear of rubbing part induced by friction and oxidation gives rise to a third body at the contact interface [1]. The flow of the third body interacts with the locations of the contact which define area of energy dissipation and contribute to thermal locations [2]. The dynamic of hot bands guides the third body [3]. Understanding these couplings is very important for braking applications. The Analysis of third body circulation based on the tracking, changing surface, the aspect and physico-chemical evolution, is obtained by the measurement of emissivity [4]. To discriminate thermal and physico-chemical phenomena, measurements of temperature and emissivity fields are essential during a braking test. This measurement is performed by the introduction of a bichromatic thermography technique using two IR cameras. To follow the evolution of these phenomena, the cameras are used to observe the same area of the disk during its deceleration, with a synchronization system. The work presented here is the development of bichromatic thermography and synchronization of imaging during a braking test on a tribometer.

Bi-chromatic thermography

Cameras with filters of the MWR (Midle Infrared Wavelength) are calibrated in radiaent flux pixel by pixel on an extended black body at high temperature. Then the images are repositioned so as to have a matching of the observed zone, by using a reference target. Under the assumption of gray body, temperature and emissivity fields are extracted. This method is validated by heating a sandblasted stainless steel of emissivity assumed (figure 1, a portion of the sample is painted black). The relative errors are less than 2% for temperature and emissivity values, for temperatures of blackbody above 200°C.

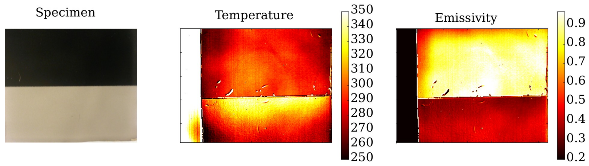

Fig. 1 - Thermal and emissivity fields of a heated sandblasted stainless steel

Synchronization

The cameras are synchronized using a system of top-turn laser sending a signal to an electronic "Arduino Due" with a micro controller, upon detection of a turn. To send a signal to trigger cameras so that they always take the same area of the disk during the test, an algorithm evaluates real-time speed, acceleration and the delays considering their response time.

With these technique, an analysis of the coupling between thermal and tribological phenomenon is performed by observing the disk surface during braking tests on a tribometer.

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