Thermal behavior of silicon carbide/carbon tribological tests

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During friction, the materials in contact undergo a thermal field that can accelerate their deterioration or promote the creation of protective layers [1]. Silicon carbide/carbon dry contact often experiences these phenomena through an oxidation process and a material transfer [2].

Three carbon samples were used in this study. The first grade was a carbon-graphite with no impregnation. The two following grades were all impregnated, first by antimony and at last, PTFE. Graphite, PTFE and antimony are commonly known as solid lubricant thanks to their accommodation mechanisms. The PTFE is a non-adhesive material due to its low surface energy, antimony is a ductile metal and can deform easily while graphite shows a lamellar structure leading to the cleavage of its layers in conditions of gaseous atmospheres or humidity [3].

The silicon carbide was a pressureless sintered silicon carbide supplied by BOOSTEC. It shows high mechanical properties, high Young Modulus and high hardness, and a high thermal conductivity (180 $W.m^{-1}.K^{-1}$).

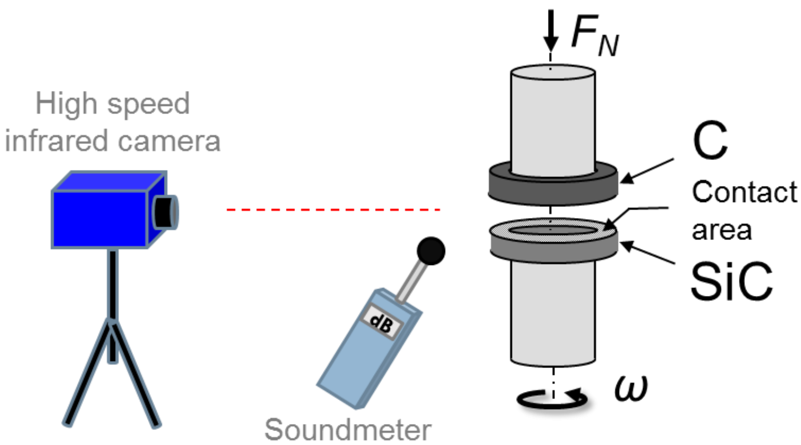

Figure 1 Schematic of the tribotests

Experiments were carried out under dry friction using a ring-on-ring tribometer at ambient temperature (*Figure 1*). Three contact pressures (0.1, 0.5 and 1 MPa) were tested for a sliding speed of 0.5 m/s during two hours. An infrared camera was focused on the samples in order to assess the thermal field in the system with a thermal resolution of 20 mK. The maximum acquisition frequency (150 Hz for full frame) and a uniform and constant value of emissivity corresponding to carbon (0.98) have been considered. A sound level meter recorded the noise emission for each couple.

Tested carbon showed a higher wear rate than silicon carbide (*Figure 2*). The non-impregnated carbon wear volume was about 160 mm^3. It was decreased by using impregnants to a value below 50 mm^3. Fiction coefficients (COF) were also affected by impregnations. While antimony stabilized the interface to the same mean value of friction coefficient, PTFE reduced it to 0.1.

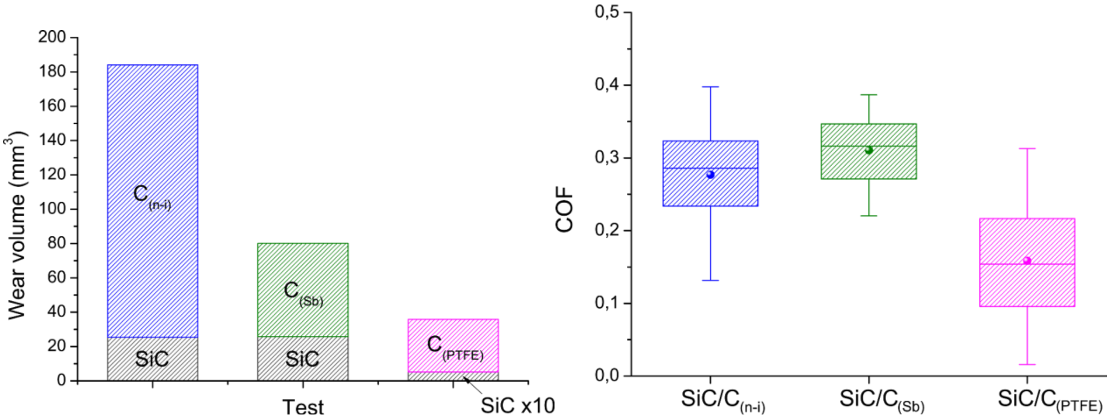

Figure 2 Wear volumes (left) and friction coefficients (right) at 1 MPa and 0.5 m/s.

SEM imaging, EDS analyses and Raman spectroscopy revealed the presence of a third body on both surfaces. This third body, circulating between the two counter-parts, is mainly composed of amorphous carbon and oxidized particles.

Finally, energetic flows were identified and a wear mechanism for the silicon carbide/carbon dry contact is proposed, with respect to the concept of the third body approach [4].

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