Thermo-mechanical and tribological analysis of pad-disc contact in a braking tribometer

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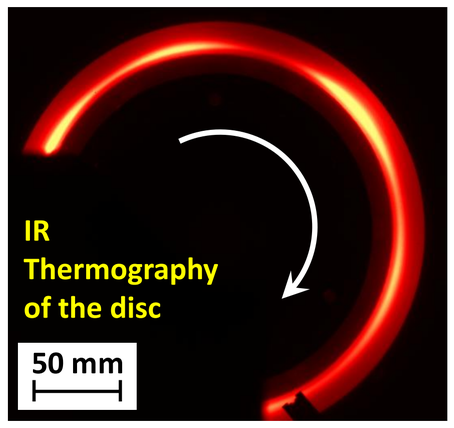
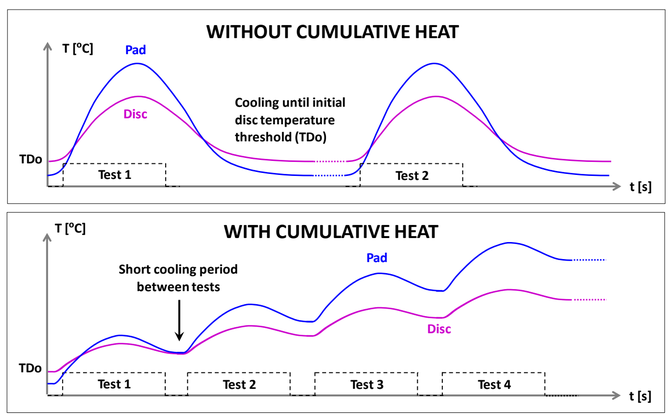
Introduction

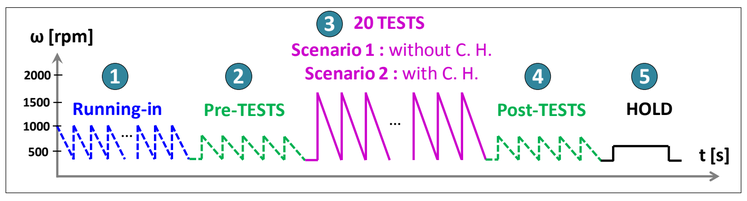
The main issue of this work is to understand the material behavior in a **disc-pad interaction** under similar mechanical conditions but different thermal backward histories. In this project, experimental tests are performed in a **braking tribometer** set-up **[1]** using a **steel disc** (C45) and a **metallic composite pad** (70 % matrix *Fe/Cu*, 20 % graphite and 10 % ceramics $SiC/ZrSiO_4$) **[2]**. Two different sequences are carried out using slowdown braking tests: (*i*) **without** and (*ii*) **with cumulative heat**. At the end of each cycle, a hold-braking test is done to restore the pad surface for both case scenarios. The surface tribological evolutions are correlated with the thermo-mechanical measurements. A comparison between both cases (*i*, *ii*) is carried out as well.



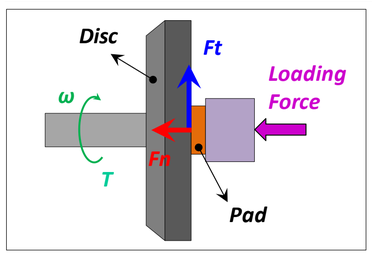


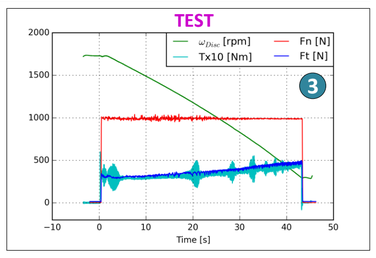
Mechanical features

Braking test sequences are composed by 5 main phases:



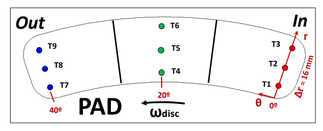
Phase	1. Running-in	2. Pre-TESTS	3. TESTS	4. Post-TESTS	5. Hold
Brakings (amount)	40	5	20	5	1
ωo [rpm]	1000	800	1700	800	500
ωf [rpm]	300	300	300	300	500
Inertia [kgm²]	5	10	10	10	---
Fn [N]	1000	1000	1000	1000	1000
Dissipated Energy [kJ]	24.9	30.2	153.5	30.2	---

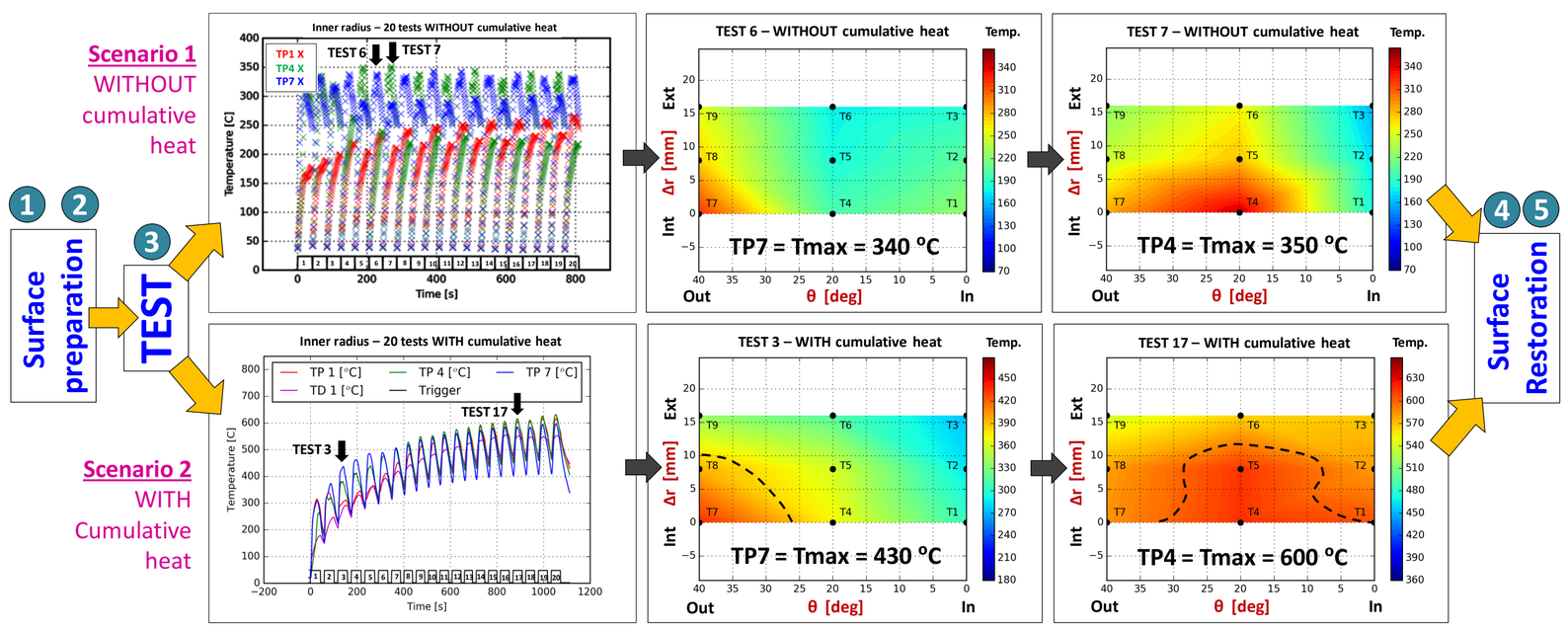




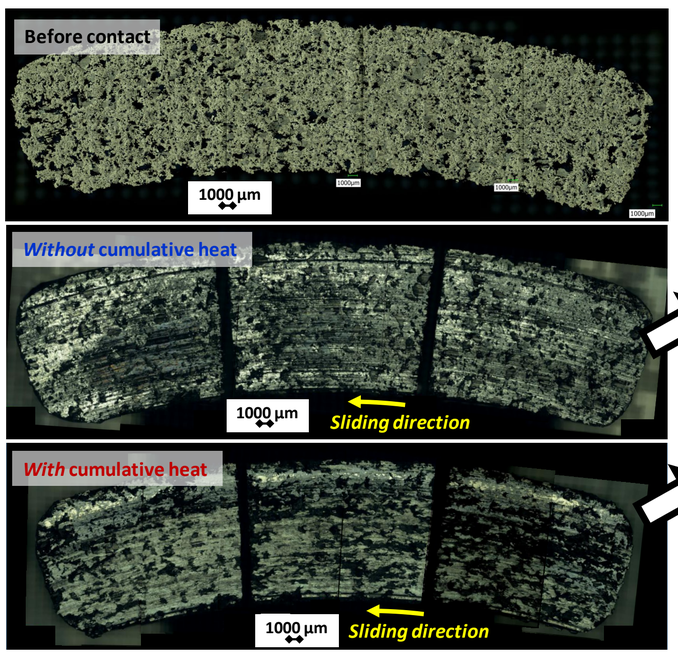
Heat evolution: pad measurements

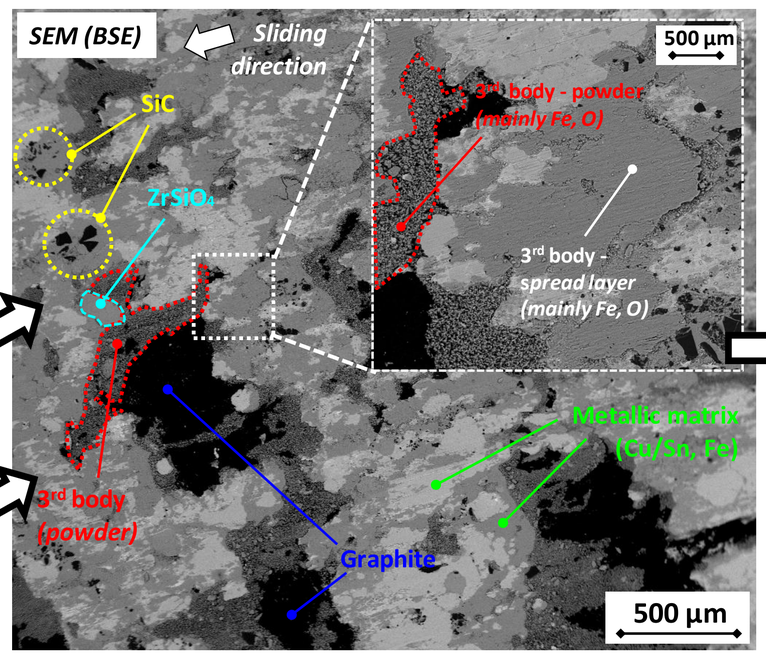
Pad temperatures are measured by thermocouples at 2 mm from the near-surface. This data permits to point out a contour map of pad temperature gradients. Despite of the thermal fluctuations, the global mechanical conditions remain the same for both cases (mean friction coefficient of 0.4).

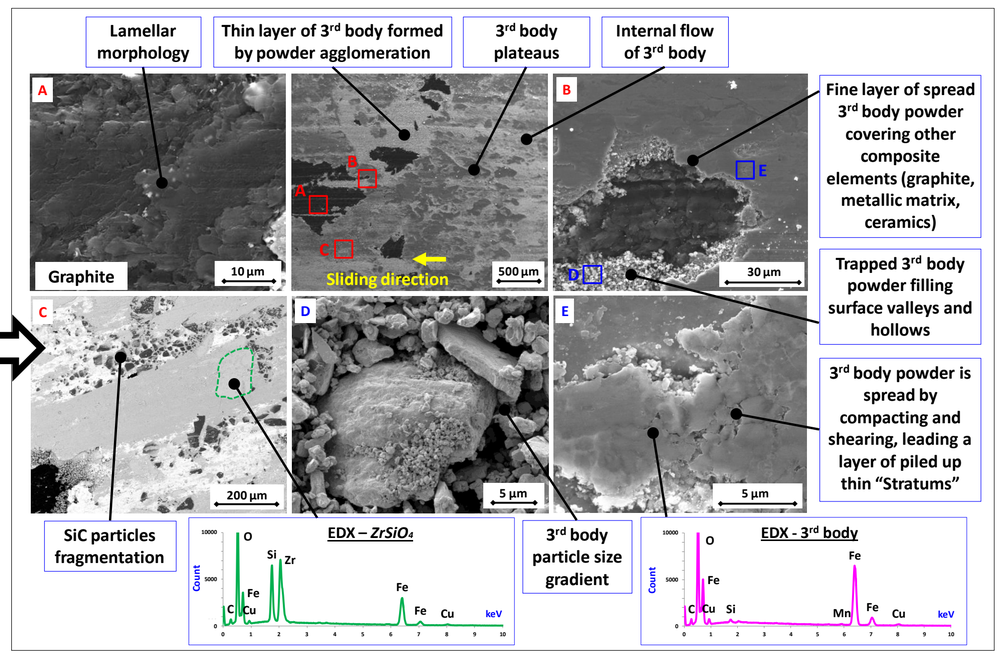




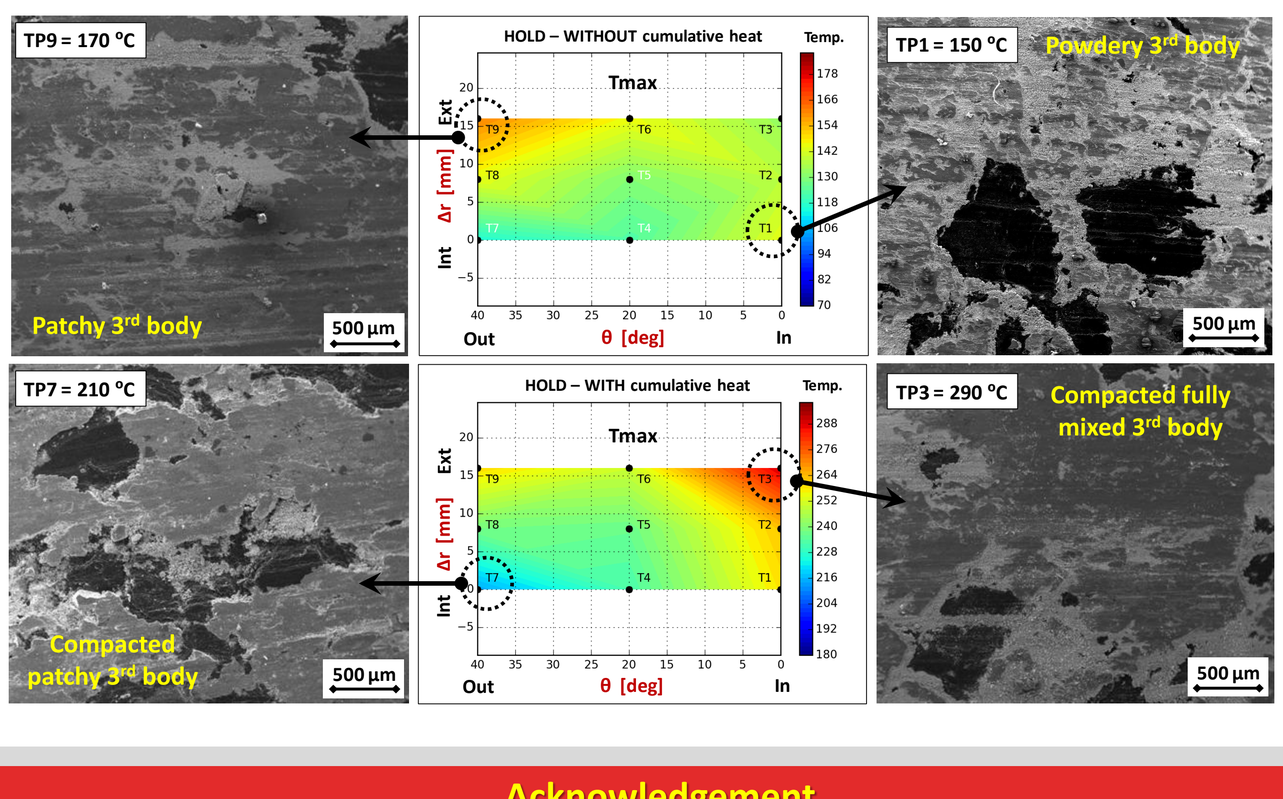
Surface evolution after contact: common aspects for both case scenarios







Morphology differences - correlation for the last contact phase



Conclusions

■ **Specific braking test sequences** were developed in order to produce fairly recurrent mechanical states and to compare two different thermal backward histories for the same disc-pad contact.

■ During the phase #3 (*Tests*), the temperature gradient reveals some **contact alternation** between the external regions and the central region of the pad. The IR thermography of the disc reveals that the contact starts in the outer radius and it **migrates to the inner regions**.

■ For the phase #5 (*hold-braking)*, the thermal gradient shows that the mechanical **contact settle on the external radius** of the pad.

■ Effect of local temperature: The surface of the pad **evolves differently according to the local temperature level** at each region. Homogeneous 3rd body plateaus appear in zones of higher temperatures (higher power dissipation) for the last mechanical phase: hold-braking.

■ **Third body morphologies:** third body in the case of "cumulative heat" sequence is compacted and fully mixed, while it is powdery in the case of "without cumulative heat" sequence.

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References:

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[2] R. Mann, V. Magnier, J.F. Brunel, F. Brunel, P. Dufrénoy, M. Henrion, *Wear*, Vol. 386-387, p. 1-16, 2017.

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