CONTRIBUTION TO THE FORMULATION OF GREEN LUBRICANTS USING LOCAL BIOMASS

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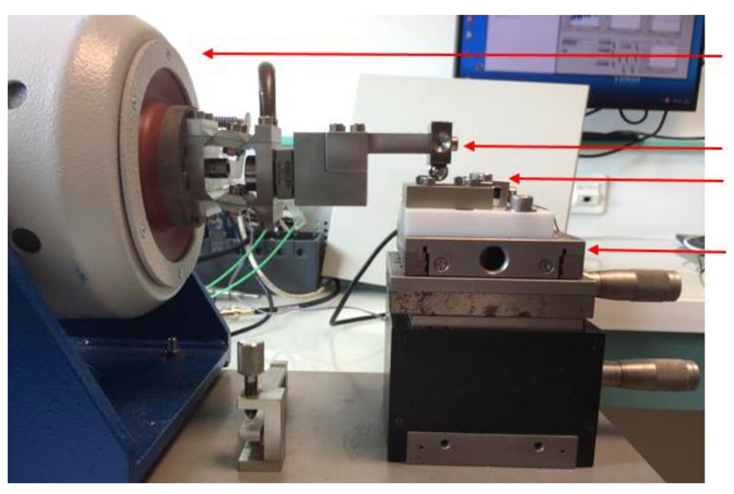
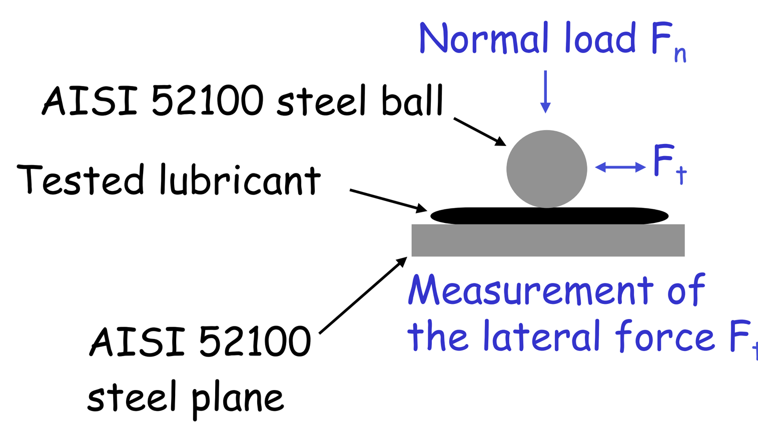
Summary

Conventional liquid lubricants are constituted of a base oil and solid additives particles presenting specific properties, such as friction reduction and antiwear performances. The role of friction reducers is to ensure the lubricating performances in boundary lubrication regime. Generally, commercial lubricants use graphite and petroleum-based oils. Graphite exhibits good friction properties attributed to its lamellar structure inducing easy shearing along direction parallel to the basal graphene sheets[1] and petroleum-based oils are used because of their well-known lubricating properties, their stability and low cost. However, such lubricants induce health and environmental hazards due to their life cycle (low biodegradability, toxicity towards environments). Many studies are now focussed on vegetable oils, which can be used as additives to petroleum-based oils because of their inherent qualities like renewability, bio-degradability and non-toxicity[2]. In order to develop green lubricants, new friction reduction additives also have to be tested. In this work, the tribological behaviour of activated carbons synthetized from local biomass is evaluated and further compared with graphite. Finally, the determination of the tribological properties of activated carbon/oils mixtures results in the first formulation step of lubricants made from local biomass.

Determination of the tribologic parameters

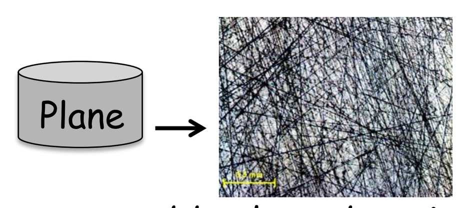




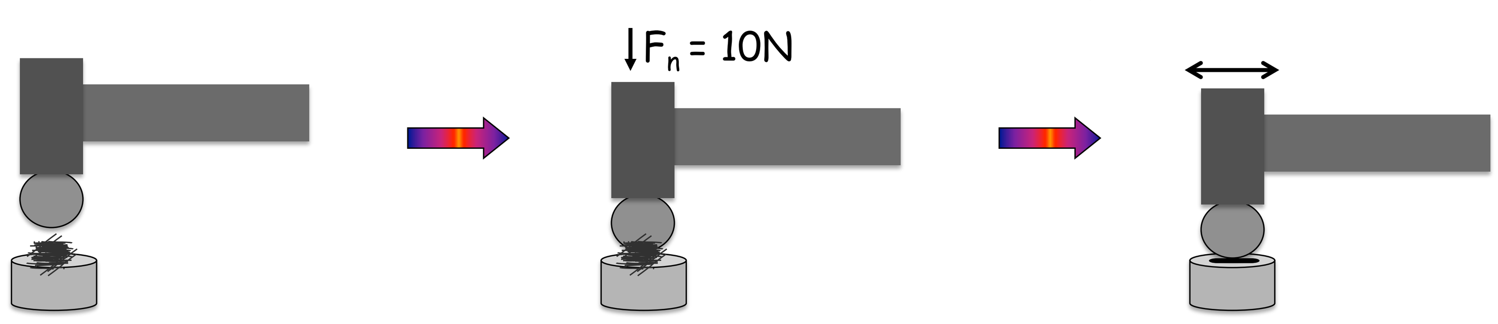
Experimental conditions:

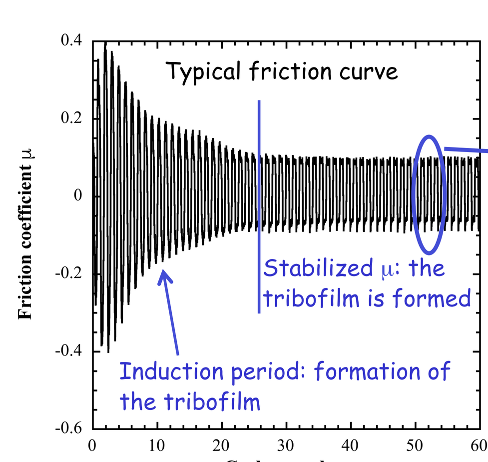
- Normal load : 10 N
- Contact area : 140 µm
- Mean contact pressure : 0.65 GPa
- Sliding speed : 3 mm/s

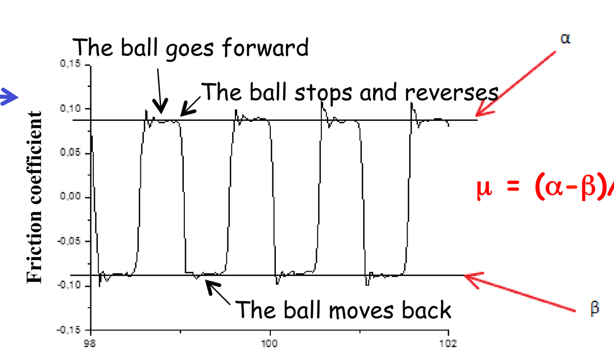
Friction coefficient: $\mu = F_t / F_n$



Planes are rubbed on abrasive paper in order to generate multidirectional scratches for better adhesion of the lubricant film

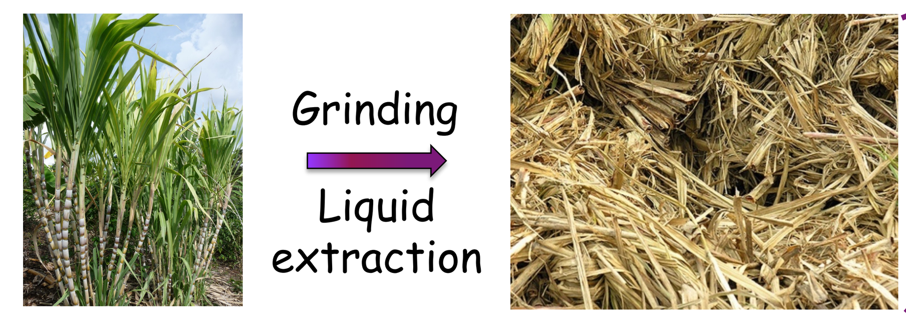






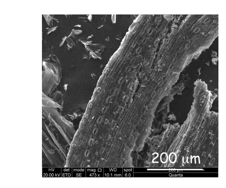
Cycle = reciprocal travel of the ball on the static plane

Biomass-derived activated carbons

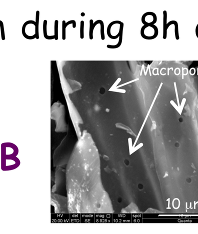


Physical activation

Biochar is obtained after pyrolysis during 1h at 800°C in N_2 atmosphere



Activation with water steam during 8h at 800°C in N_2 atmosphere

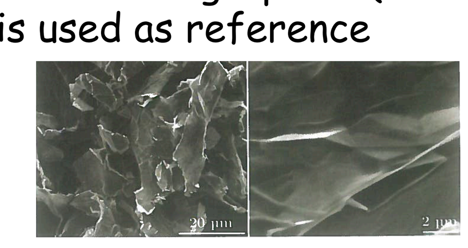


Chemical activation

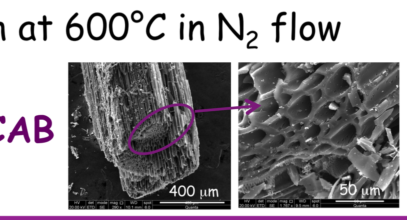
Impregnation of raw material with H_3PO_4 for 24h (g H_3PO_4/g precursor = 1)

Pyrolysis during 1h at 600°C in N_2 flow

Exfoliated graphite (Timcal) is used as reference

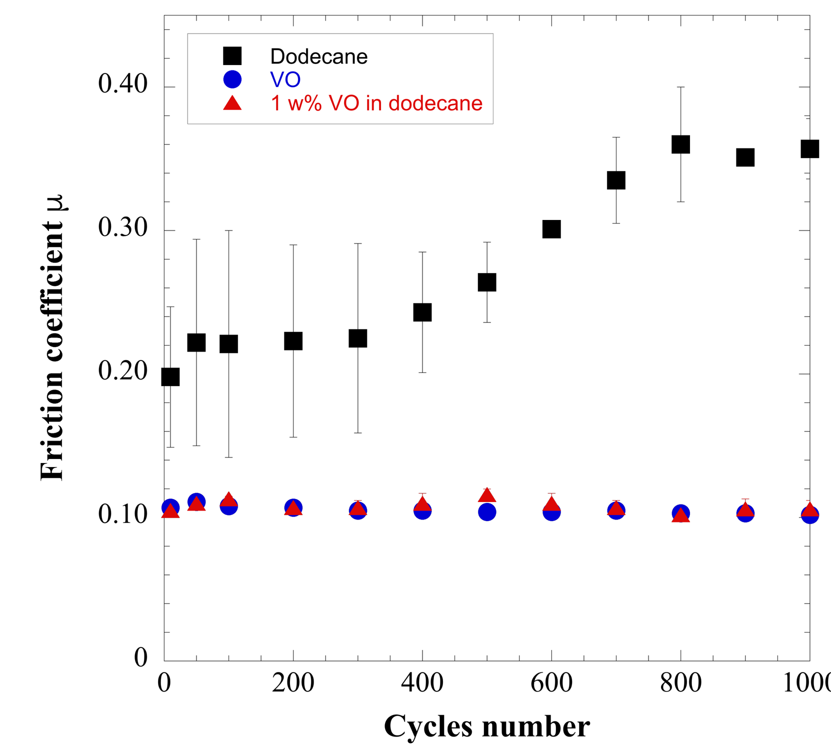


	Biochar	CAB	PAB
S_{BET} (m^2/g)	222	1030	1242



Base oil

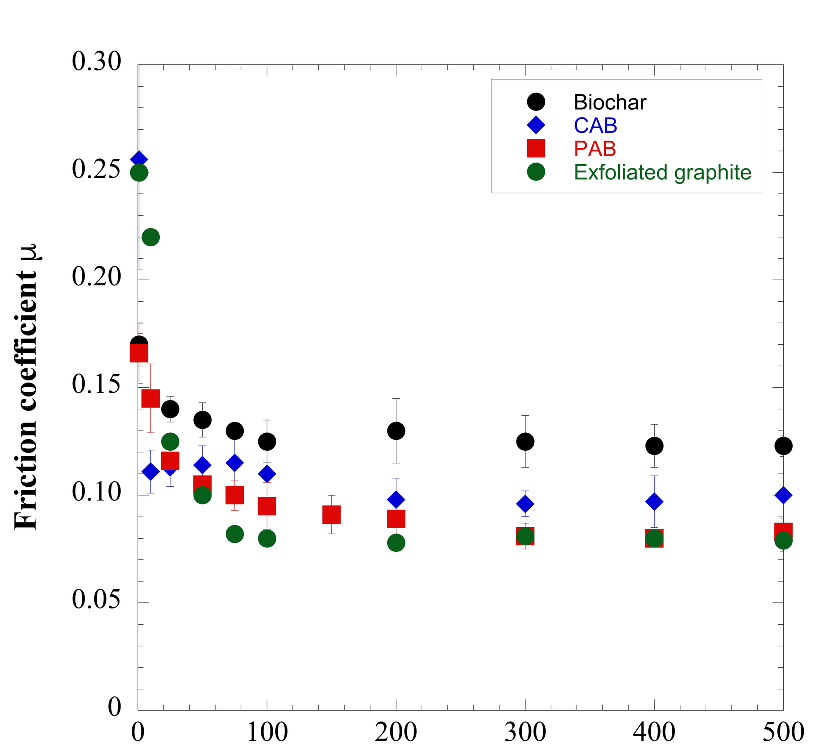
Dodecane is used as reference petroleum-based oil and local vegetable oil (VO) is tested

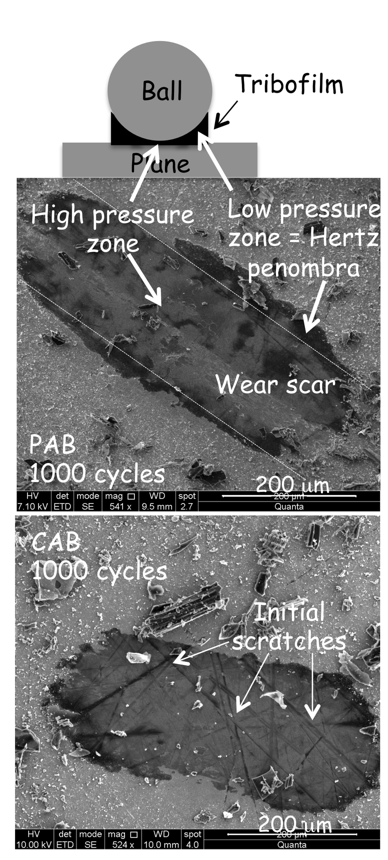


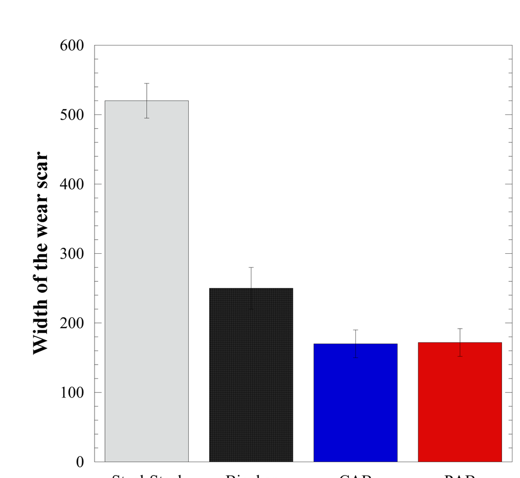
- Local vegetable oil presents better friction properties than dodecane
- 1 w% of VO in dodecane allows to obtain good lubricating performances

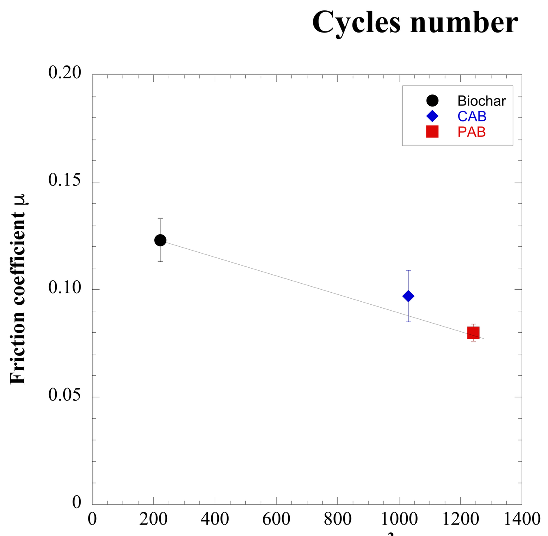
Biomass-derived carbons as friction reduction additives in lubricants

Intrinsic friction performances and antiwear properties of pure biomass-derived activated carbons



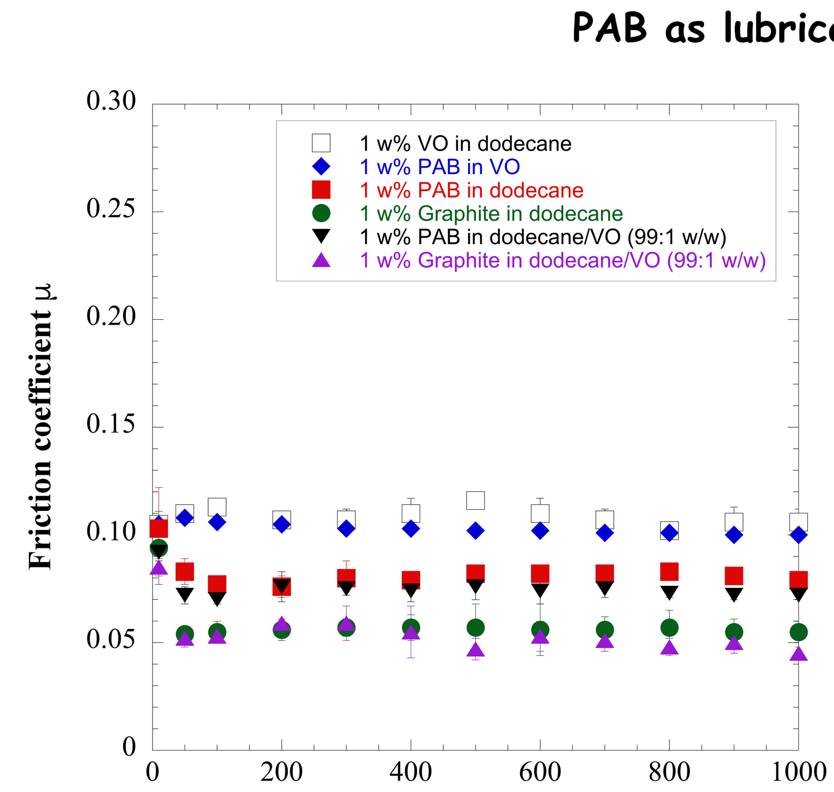




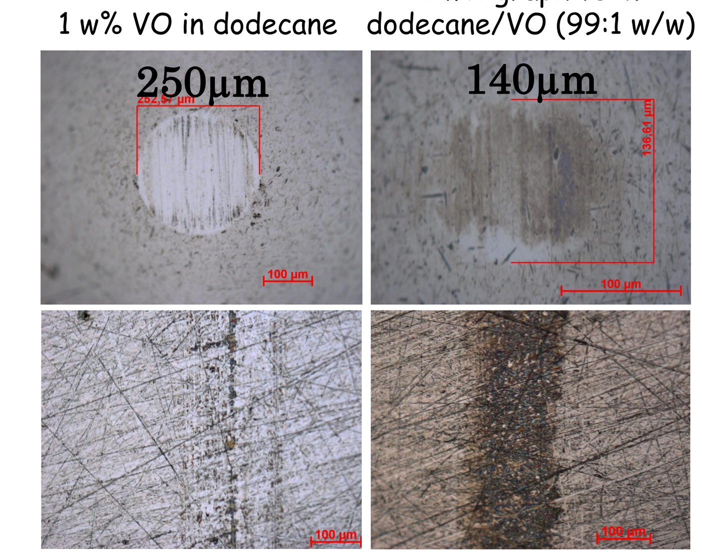


- Activation strongly improves the friction properties of the carbon phase: µ decreases as the specific surface area increases
- PAB exhibits very good intrinsic lubricating performances: µ ≈ 0.08
- Activation improves the antiwear properties of the compounds
- Initial scratches of the planes are still visible after 1000 cycles of friction: weak wear

PAB as lubricant additive



1 w% VO in dodecane | 1 w% graphite in dodecane/VO (99:1 w/w)



- The addition of PAB in dodecane/VO mixture improves the lubricating performances and the antiwear properties of the lubricant
- The interactions between PAB and vegetable oil have to be investigated
- Optimization of the friction properties of biomass-derived carbons are in progress by tuning the synthesis conditions in order to determine the most favorable porosity/graphitization degree ratio

Biomass-derived activated carbons can be used as friction reducers in lubricants

Conclusion

This work shows that biomass-derived carbons present interesting intrinsic friction and antiwear properties. Activation of biochars improves the lubricating performances of the carbon phases, the friction coefficient decreasing as far as the specific surface area increases. Very low friction coefficients can be obtained by selecting the adequate precursor and tuning the synthesis conditions. The good friction properties of activated carbons/VO/petroleum-based oil mixtures allow biomass-derived carbons to be used as friction reduction additives in environmentally friendly liquid lubricants.

References

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