

Measuring Grease Tackiness Objectively

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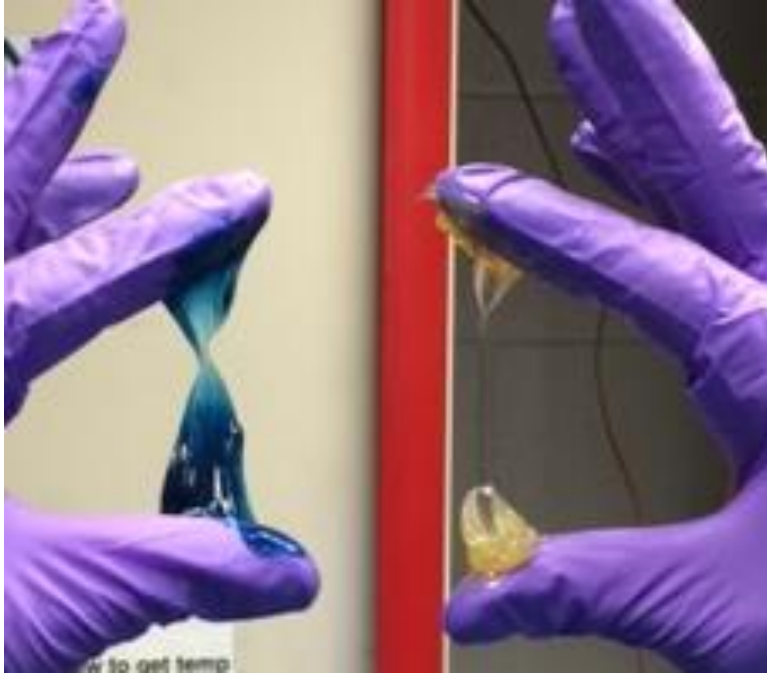
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Outline/Content

- What is the tackiness of greases?
- How can we measure tackiness?
- New Falex TAA indentation/retraction test
- Evaluating TAA method by formulated greases
- Conclusions

What is tackiness and how can we measure it?

What is the tackiness of greases?



‘Tackiness’ is considered as the ability of a grease to form threads when pulled apart.



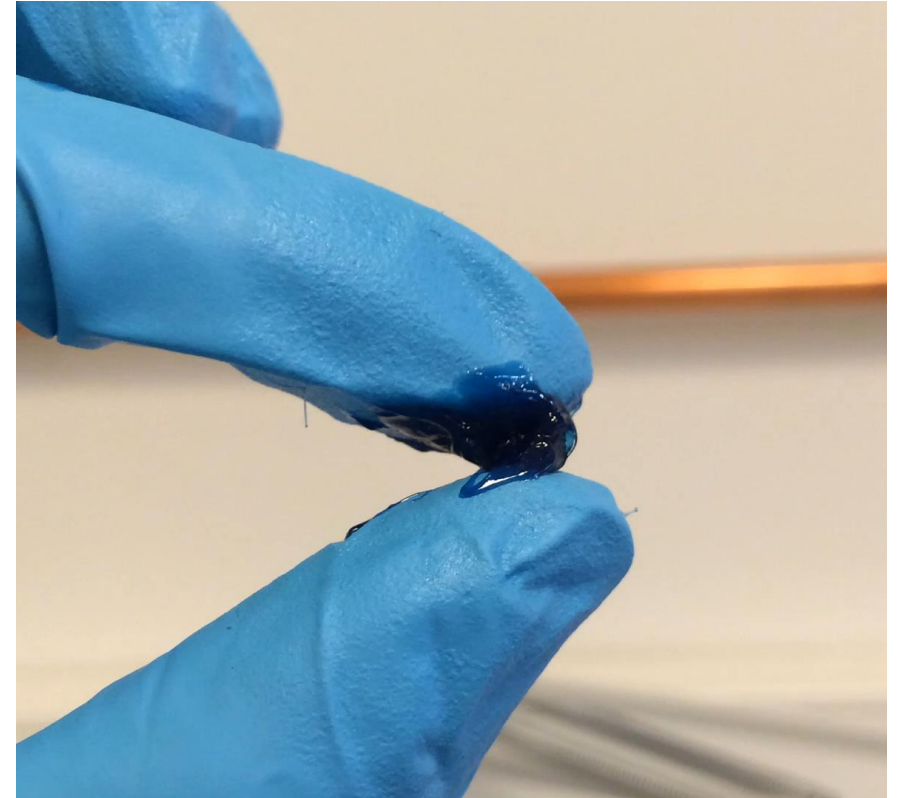
Different applications → Different requirements

How can we measure tackiness ?

How can we measure tackiness ?

State of the art

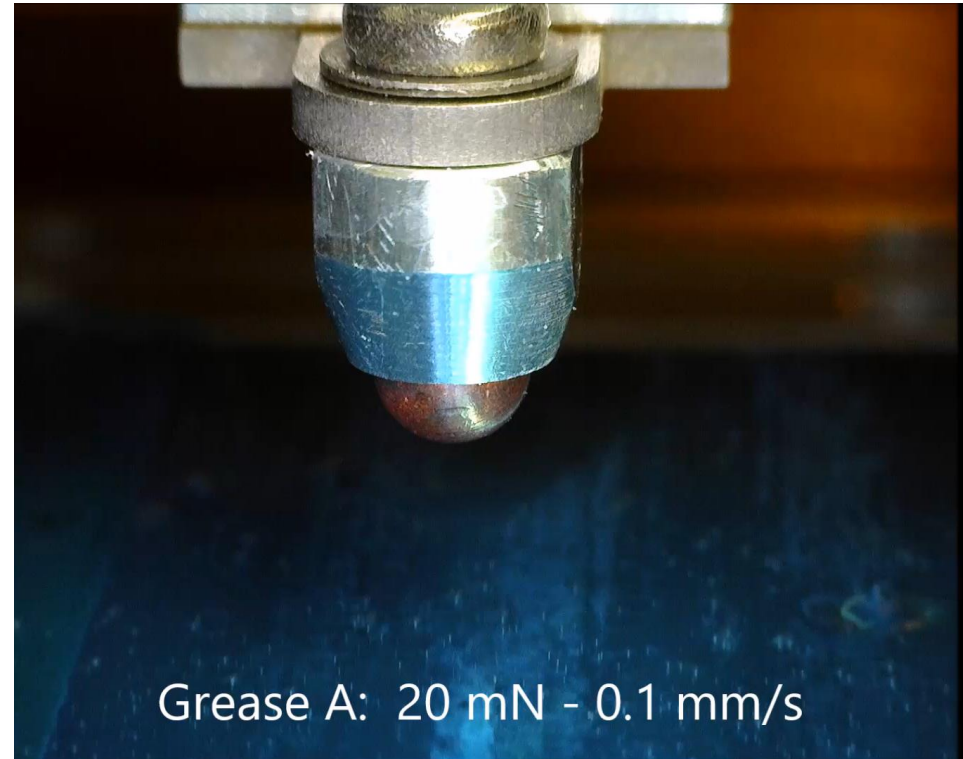
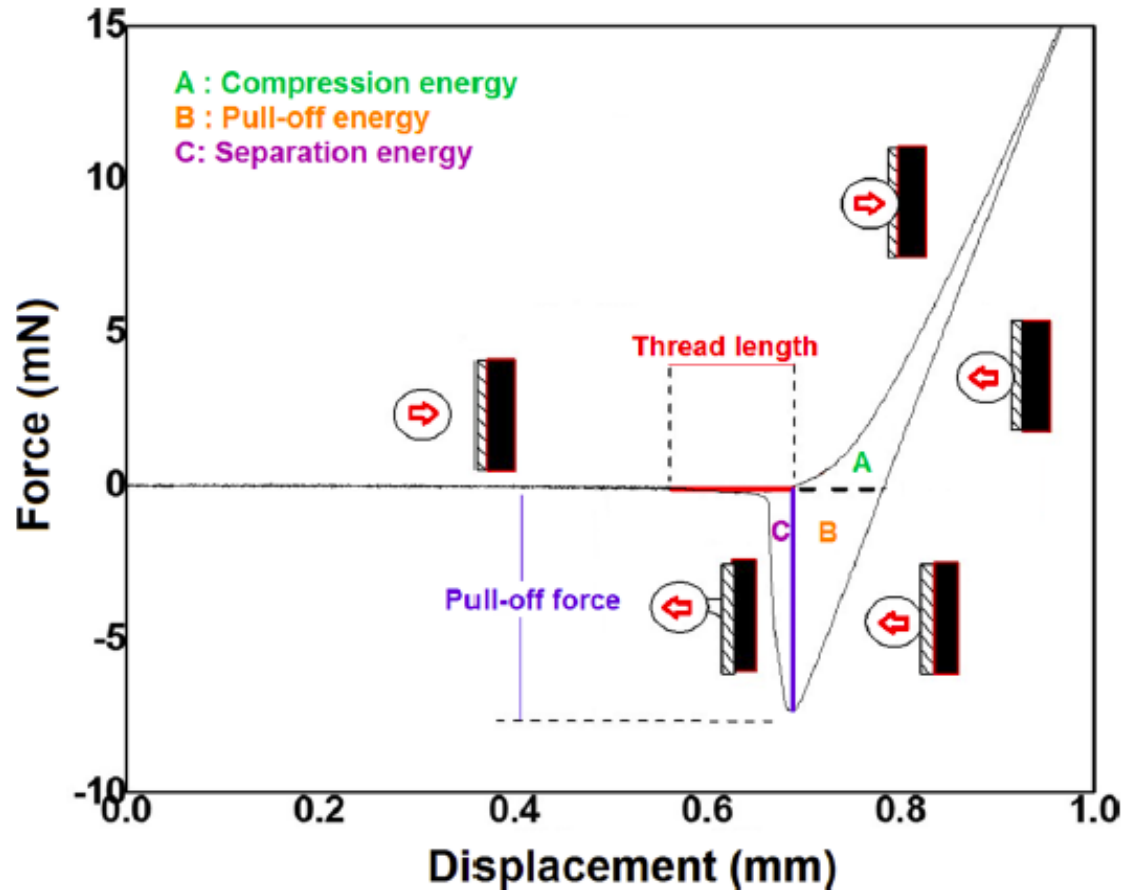
- Finger test: subjective !
 - User dependent
 - Speed dependent
- 'Tack tester' : only measures maximum pull-off force
 - Adhesion \neq thread formation
 - No speed dependence simulated



There is a need for a objective quantitative method

New Falex TAA indentation/retraction test

Principle of method



Testing procedure

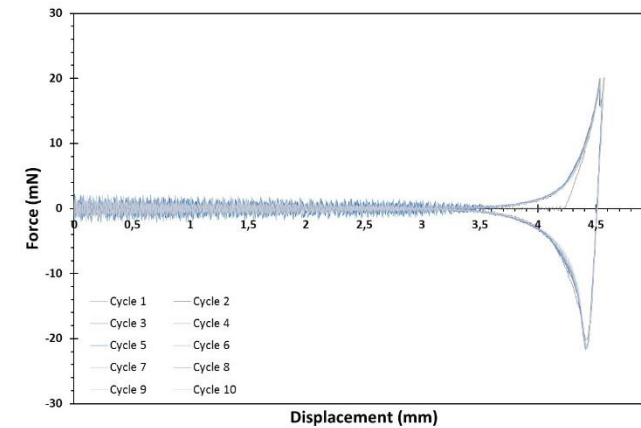
Apply a grease layer on the holder

Fix holder on tester

Perform tackiness tests

Analyze indentation/retraction curves

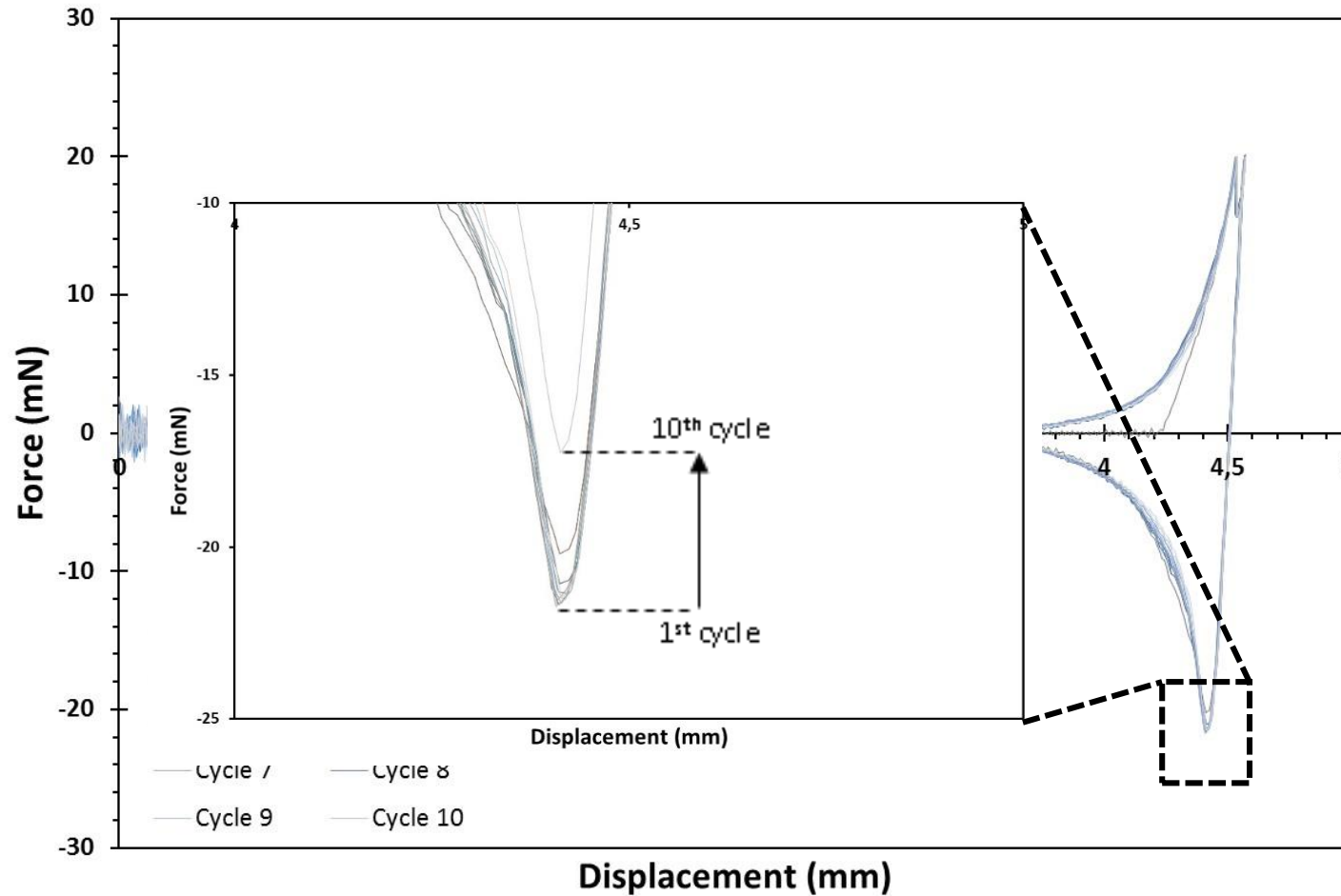
Obtain tackiness and adhesion values



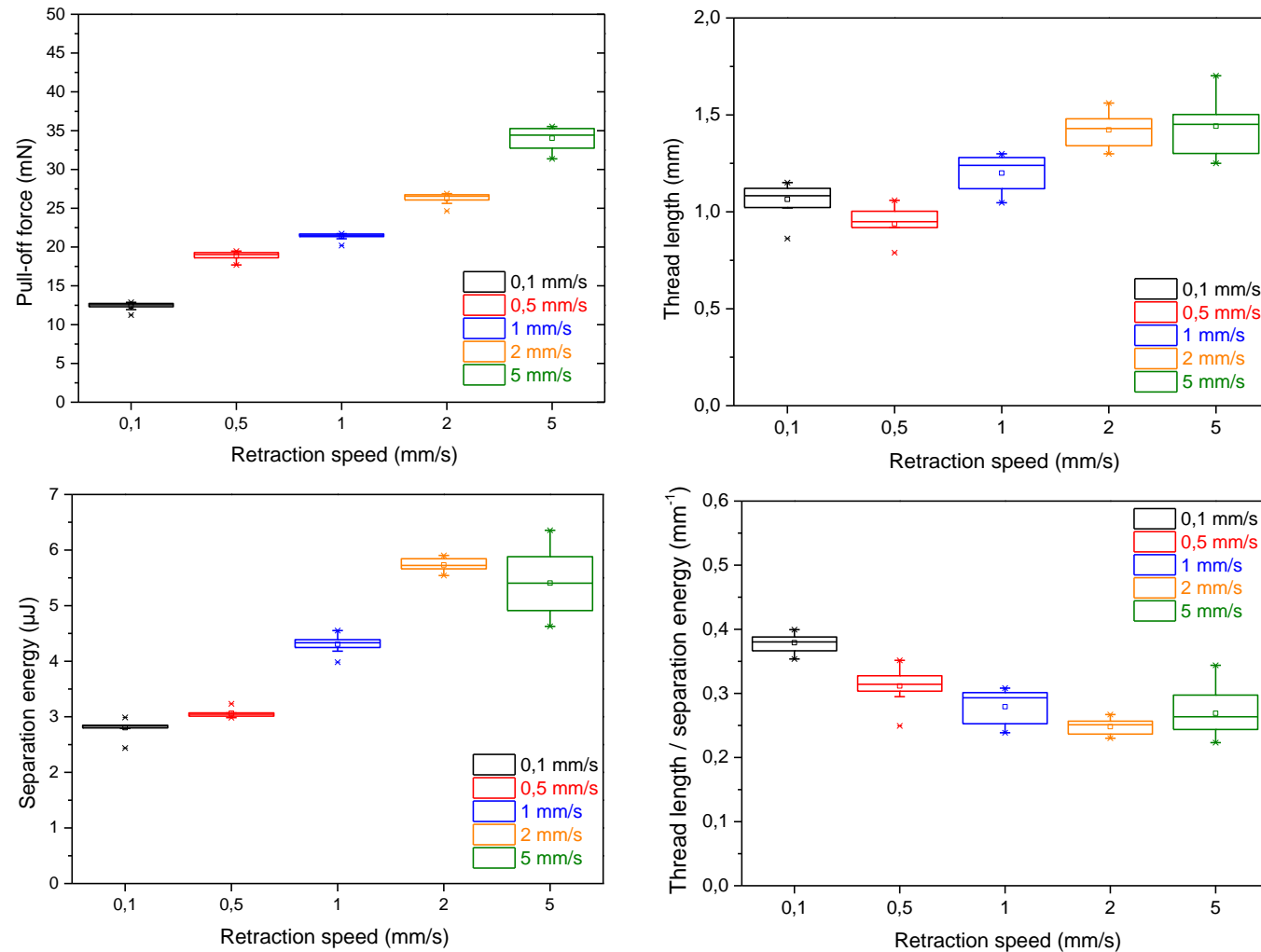
Testing conditions for this study

Test Parameters	
Test equipment:	TAA tester
Samples:	Grease layer
Grease thickness (μm):	200
Substrate:	AISI 52100 <i>(other materials can also be used)</i>
Substrate Ra roughness (μm):	0.04
Countermaterial:	Cu ball <i>(other materials can also be used)</i>
Counterface diameter (mm):	3,175 <i>(other diameters possible)</i>
Approach speed (mm/s):	0.05
Maximum indent load (mN):	10 up to 50
Waiting time at max load (s):	5
Retraction speed (mm/s):	0.1 up to 5
Temperature ($^{\circ}\text{C}$):	20 up to 100

Typical real indentation/retraction curves

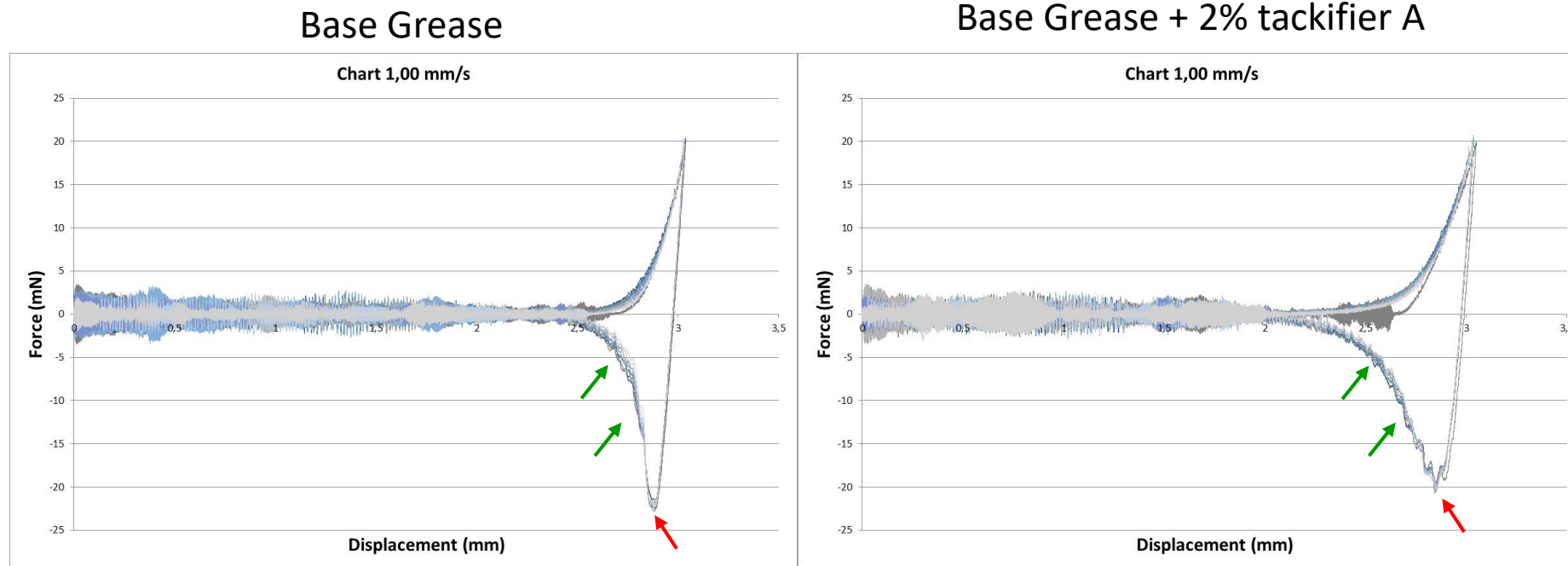


Automatic analysis of measurements one series of tests, run automatically



Evaluating TAA method by formulated greases

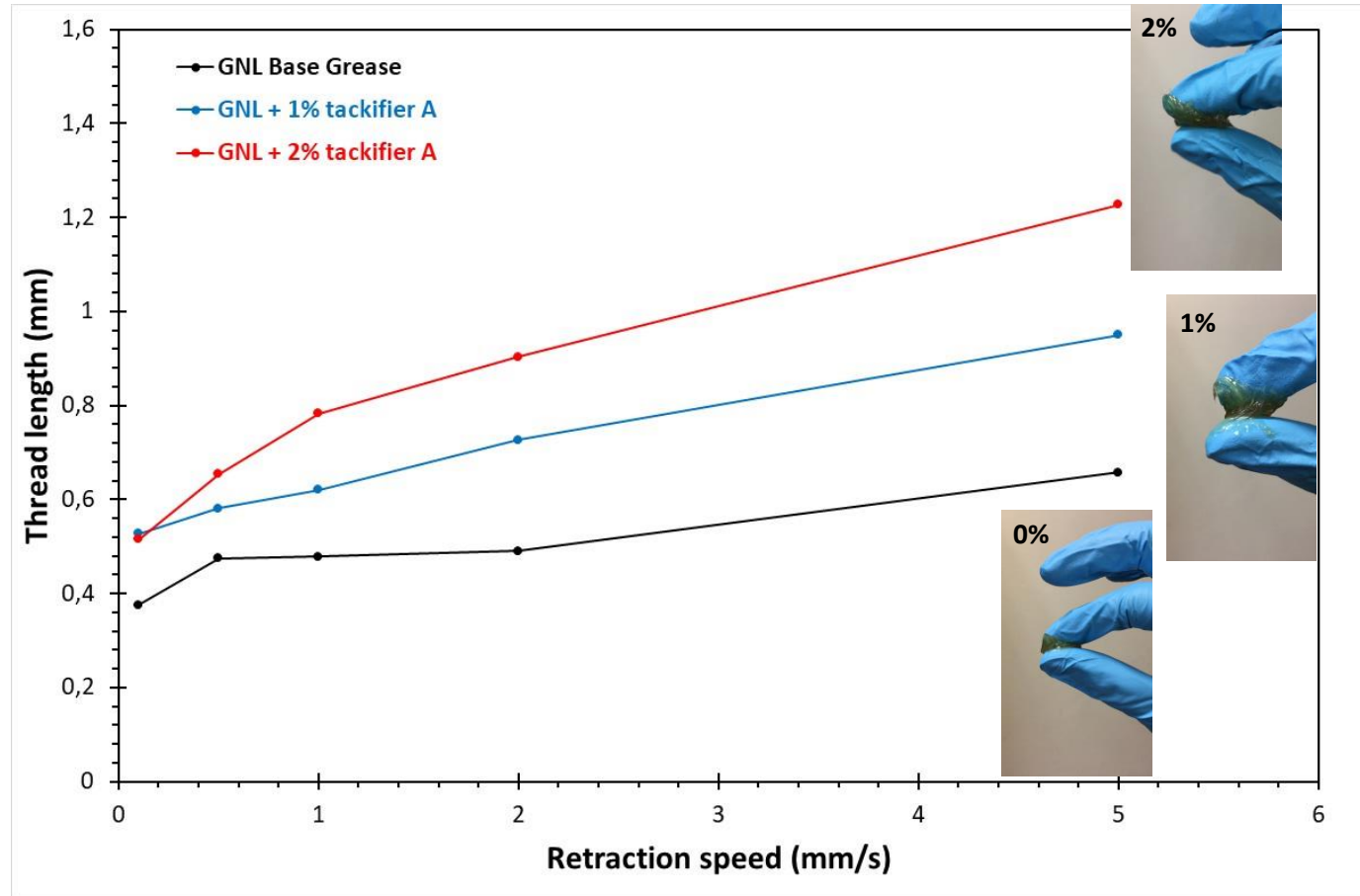
Effect of tackifier content on GNL grease



Red arrows indicate **pull-off force**

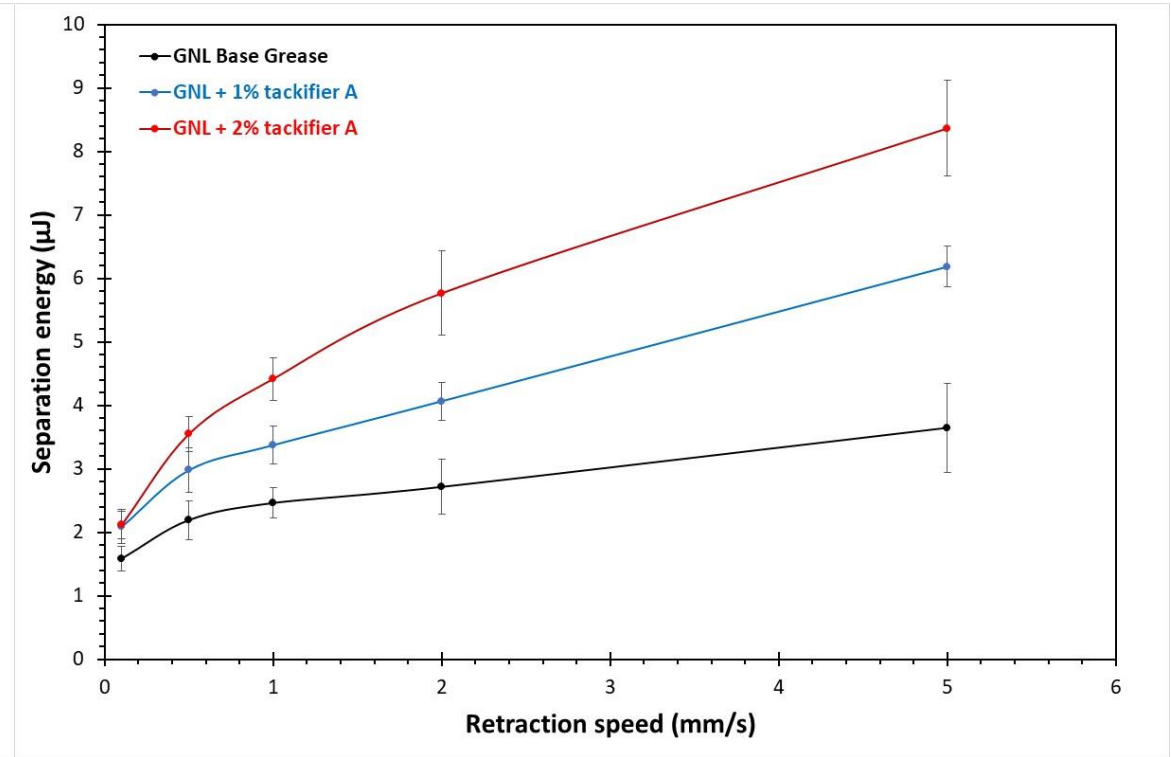
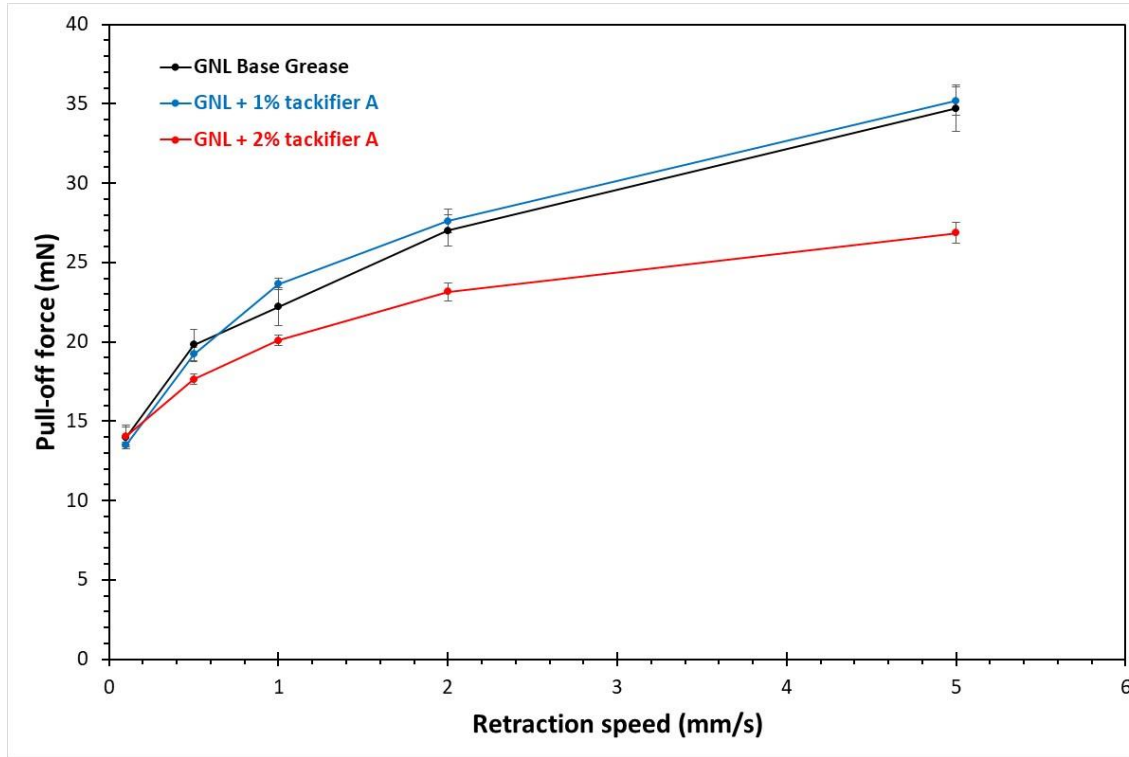
Green arrows indicate force due to **thread formation** (tackiness)

Effect of tackifier A on GNL grease



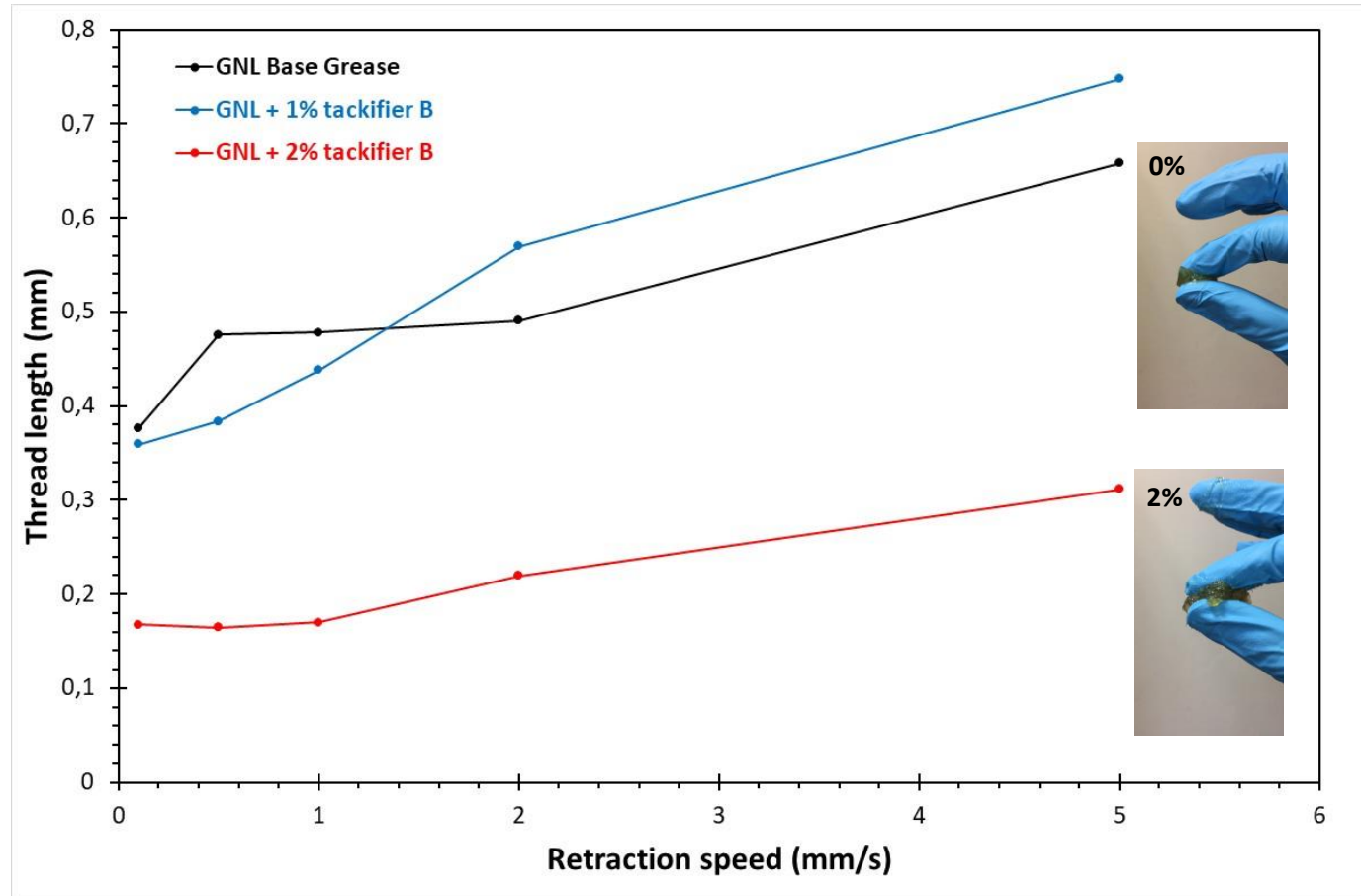
Measurements match with finger test observations
Measurements quantify effect of concentration

Effect of tackifier A on GNL grease

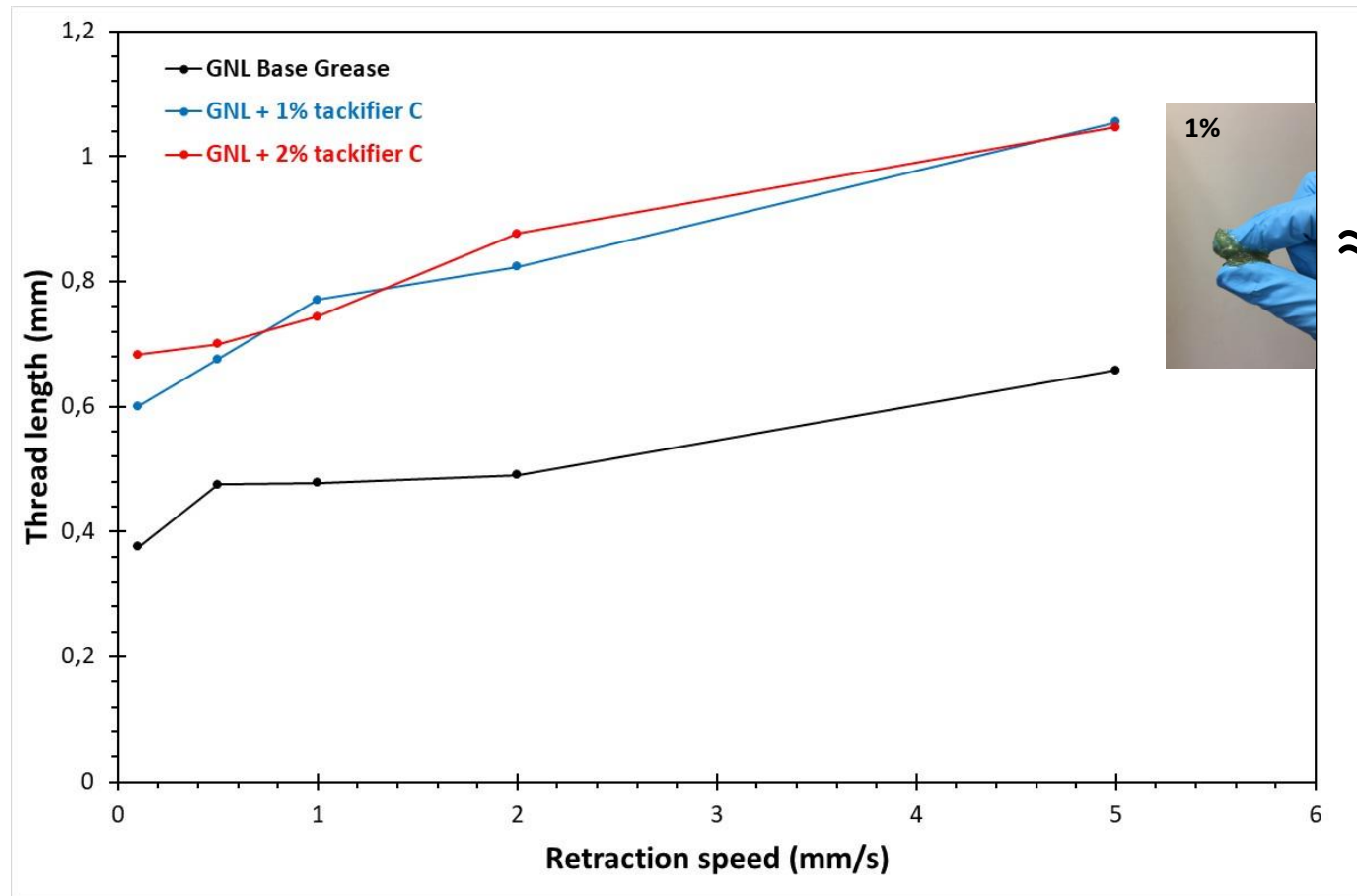


Increase of tackifier content resulted in lower pull-off force: **adhesion \neq tackiness**
Separation energy correlates with thread length

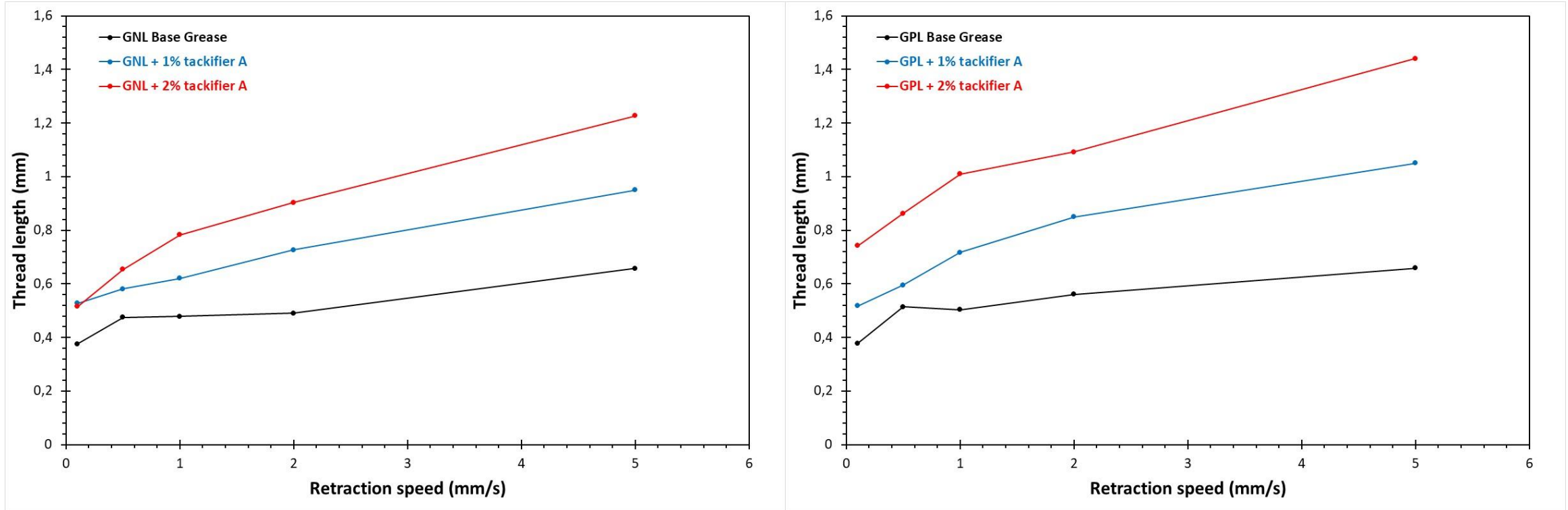
Effect of tackifier B on GNL grease



Effect of tackifier C on GNL grease

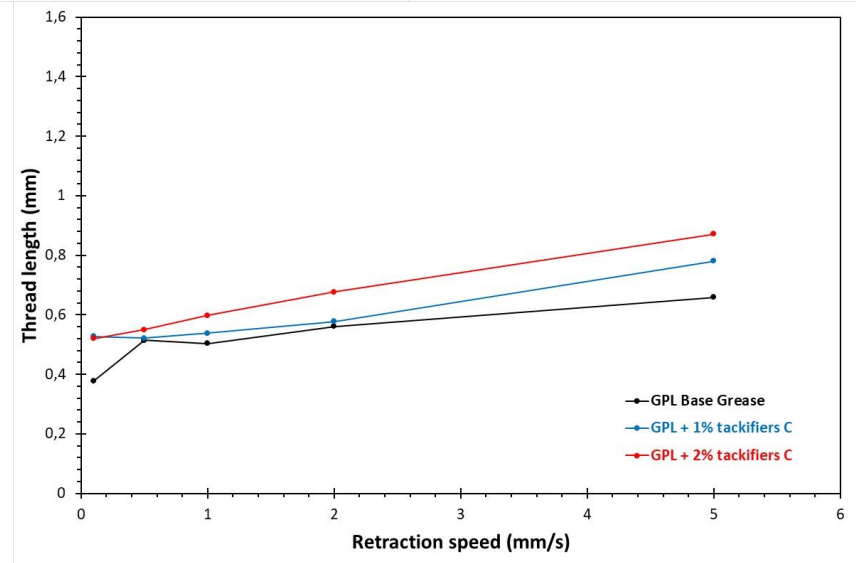
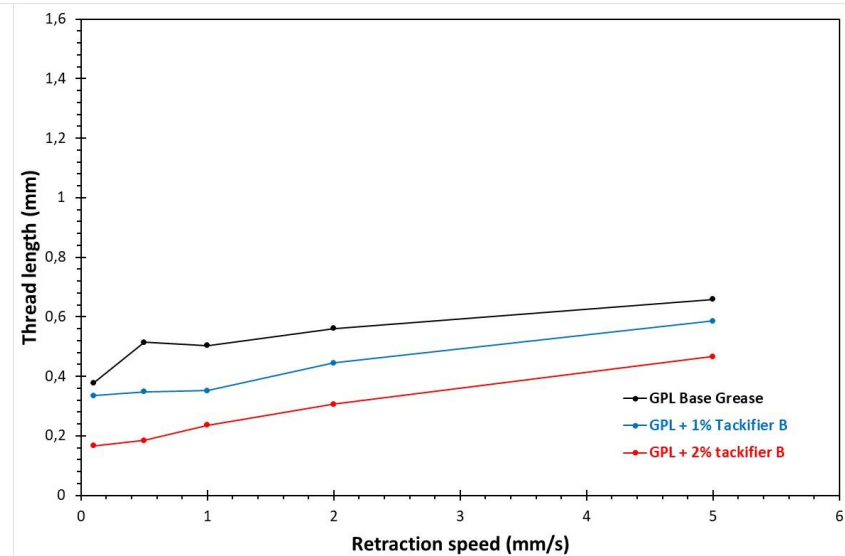
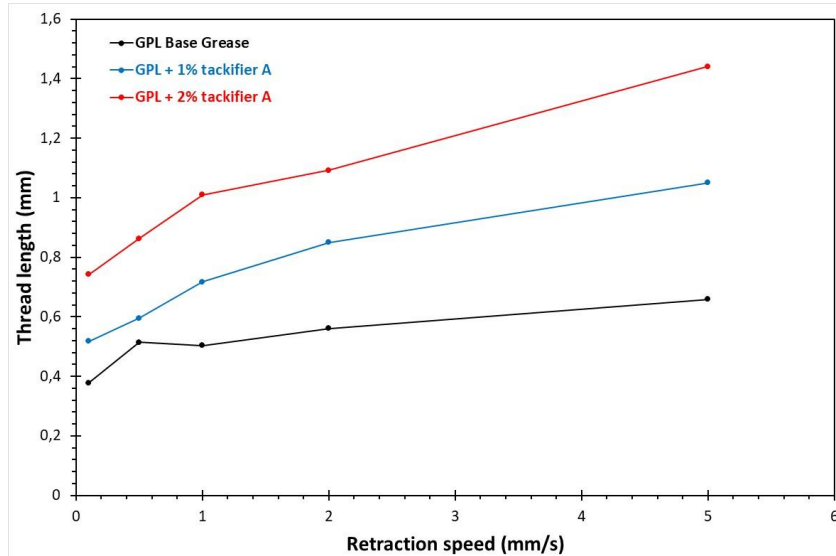


Effect of base grease on tackiness

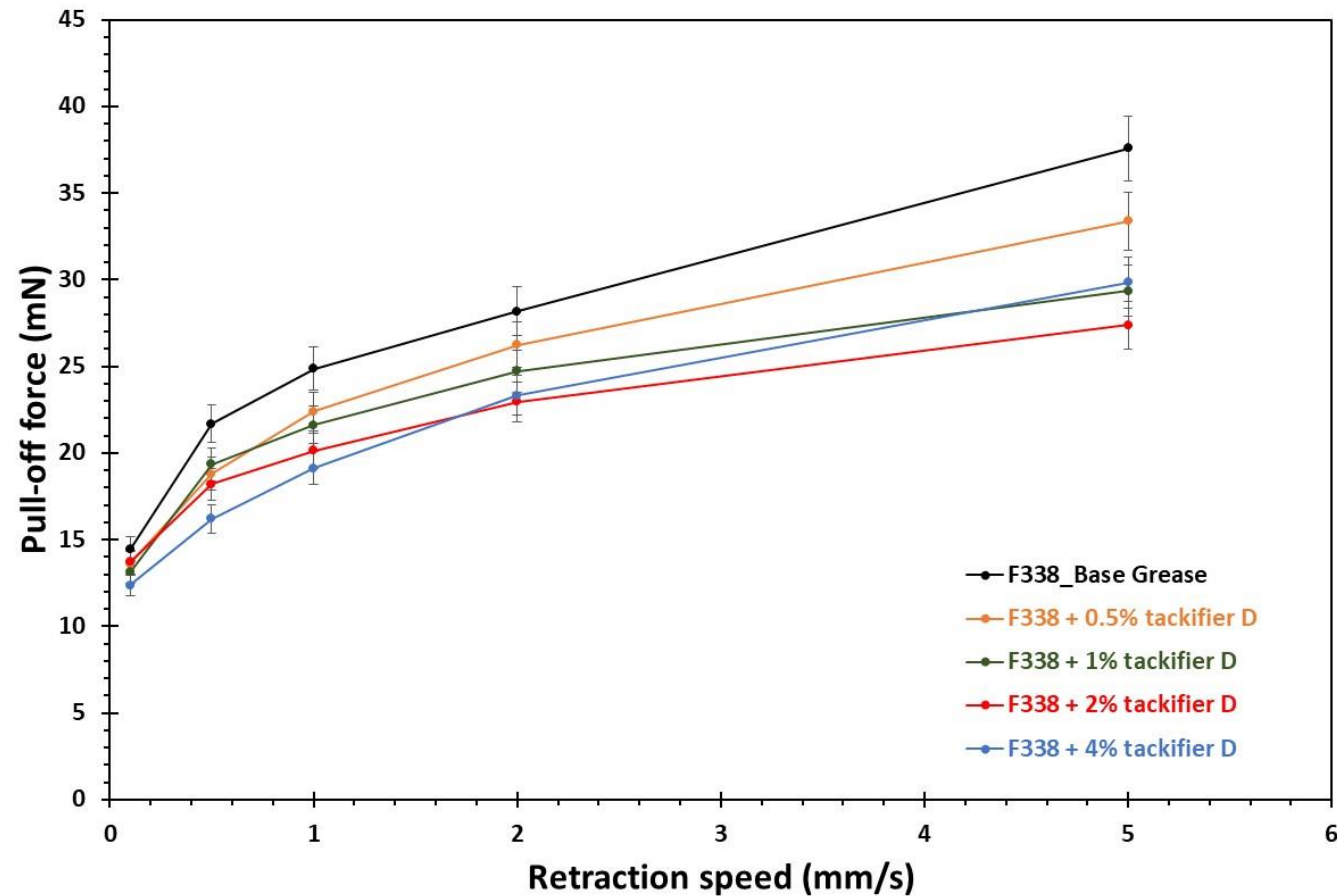


Different influence depending on base grease composition

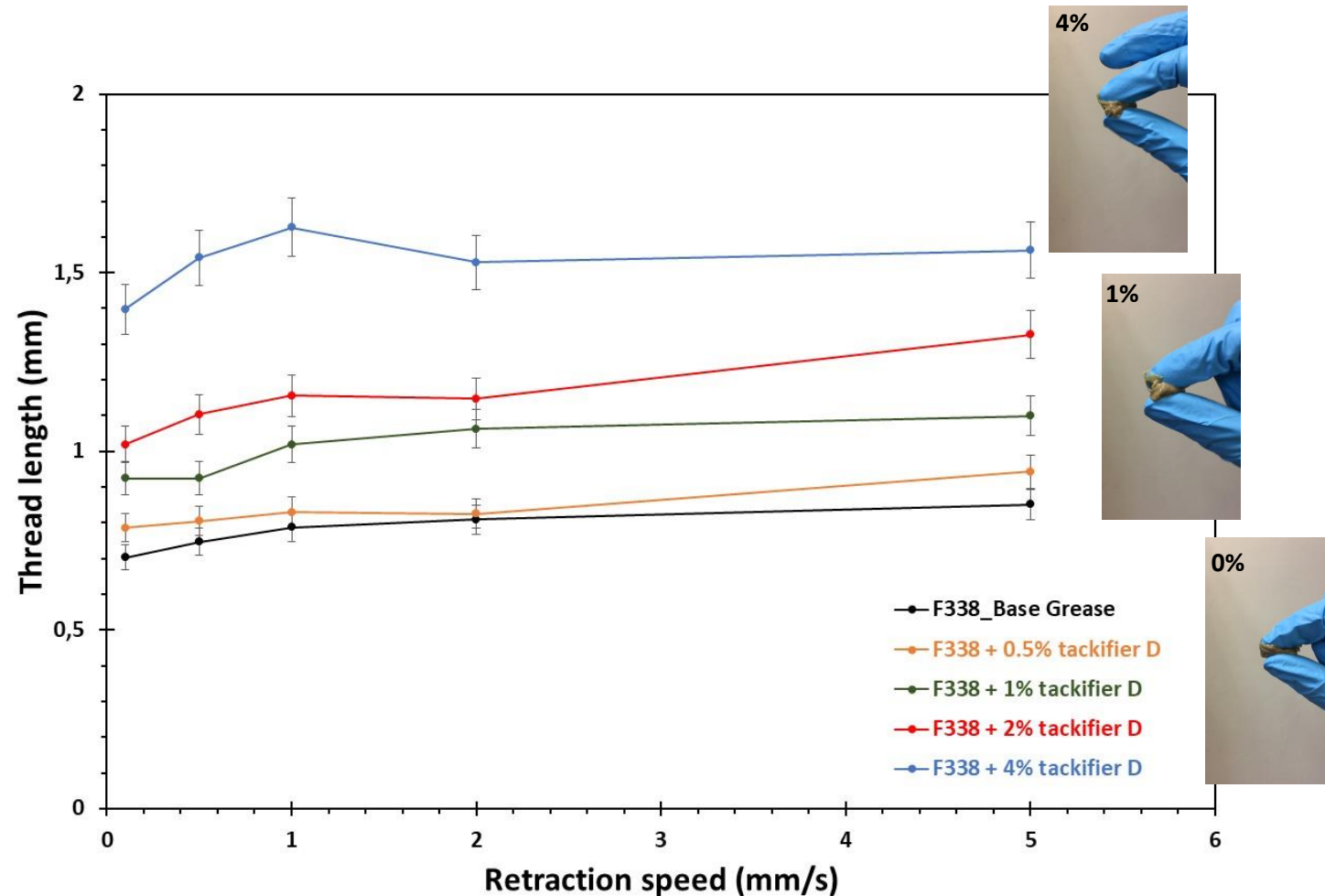
Effect of tackifiers on GPL grease



Sensitivity of method: Pull-off force

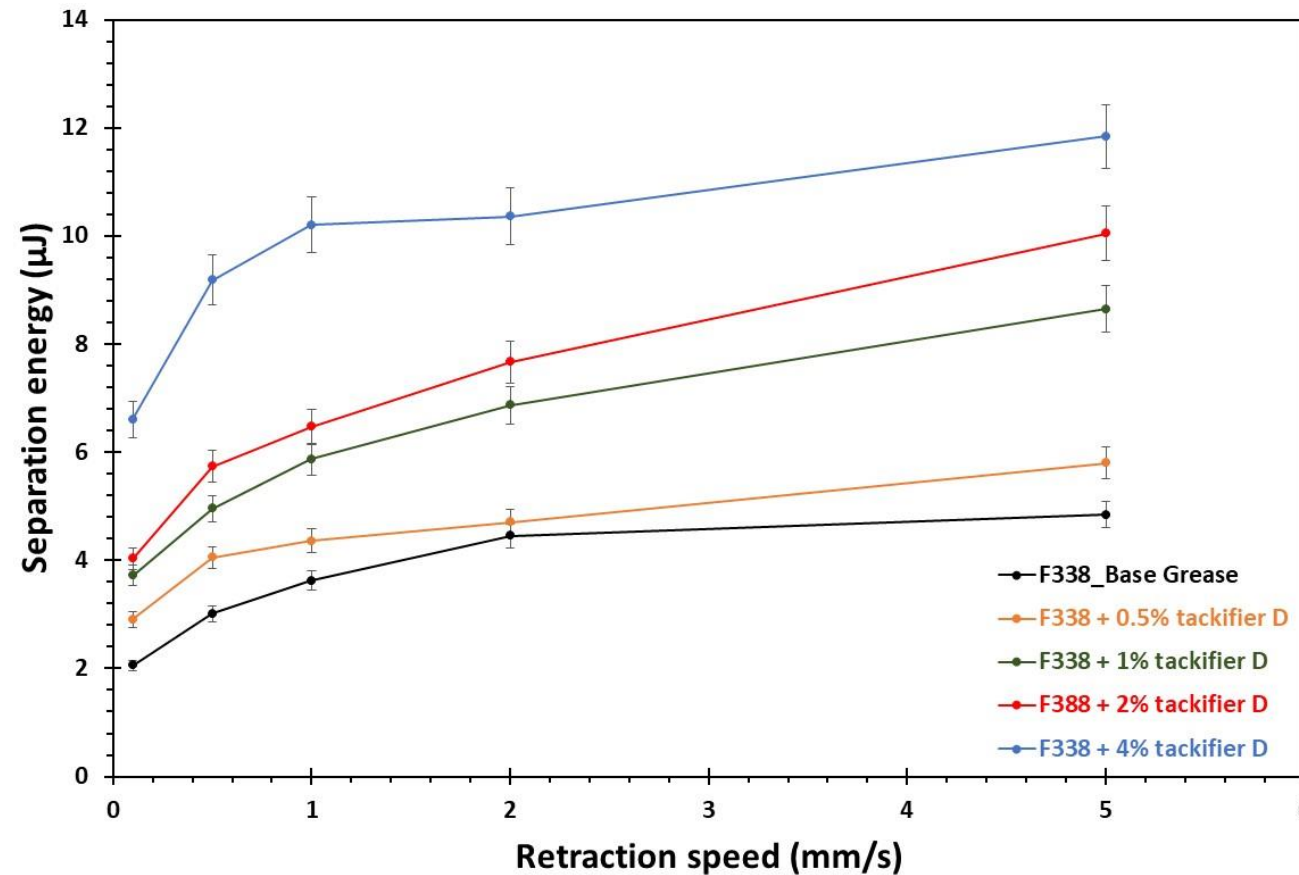


Sensitivity of method: Thread length



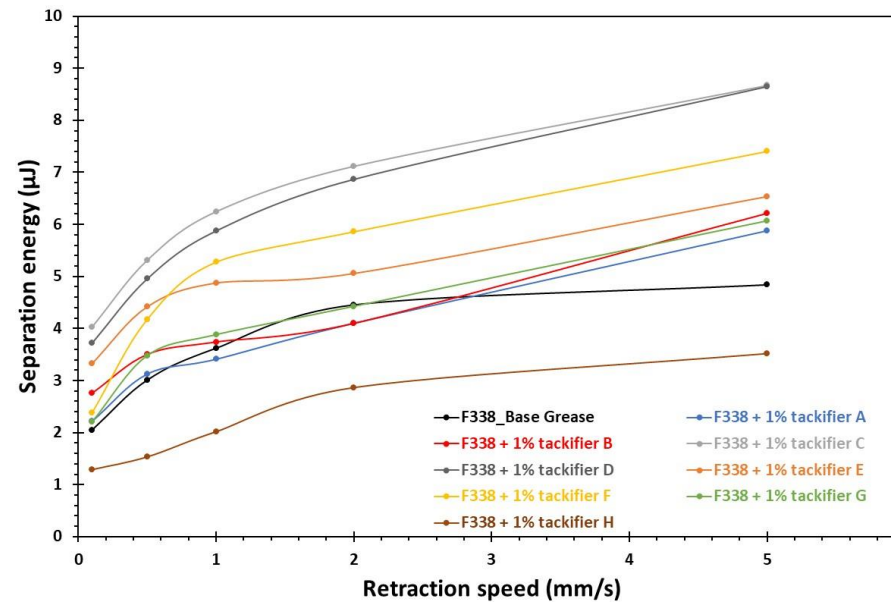
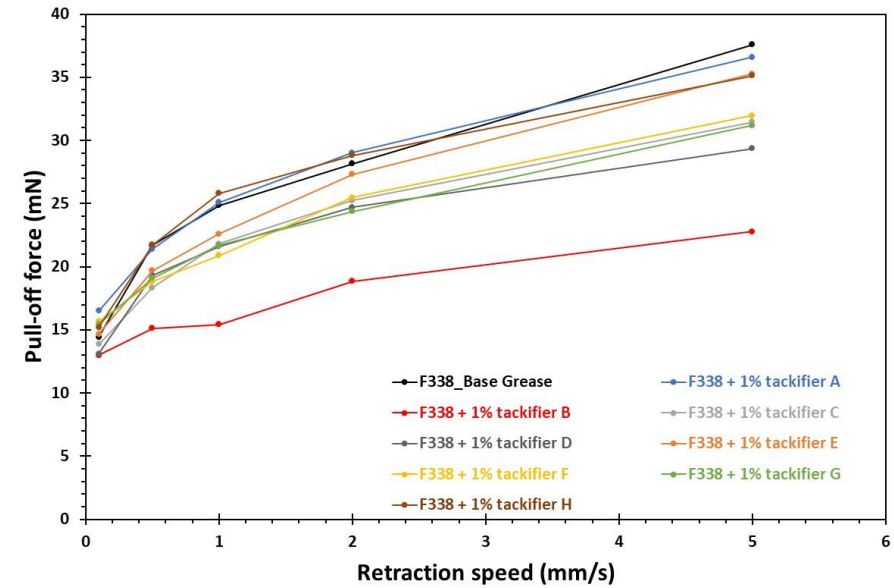
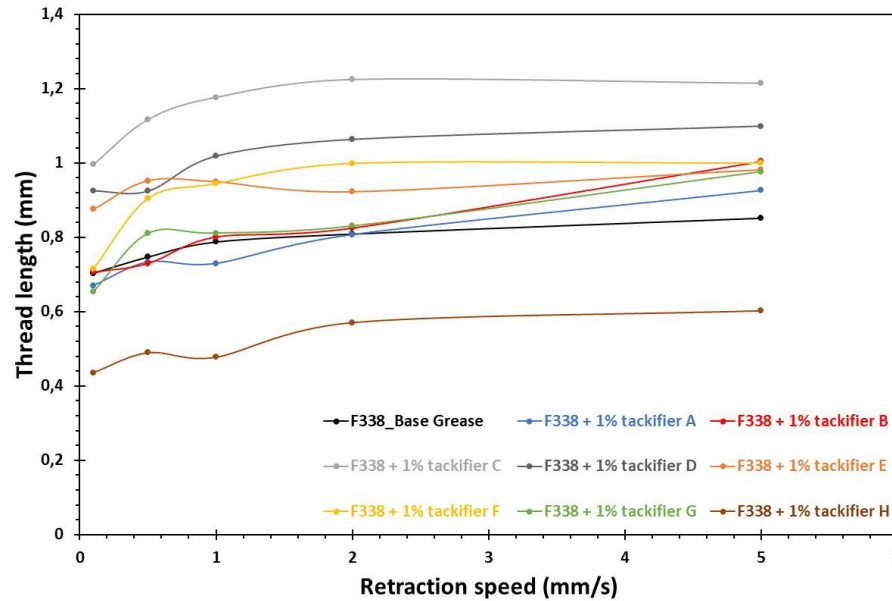
Measurements match with finger test observations !

Sensitivity of method: Separation energy



Higher separation energy means that longer threads are being formed

Ranking of different tackifiers

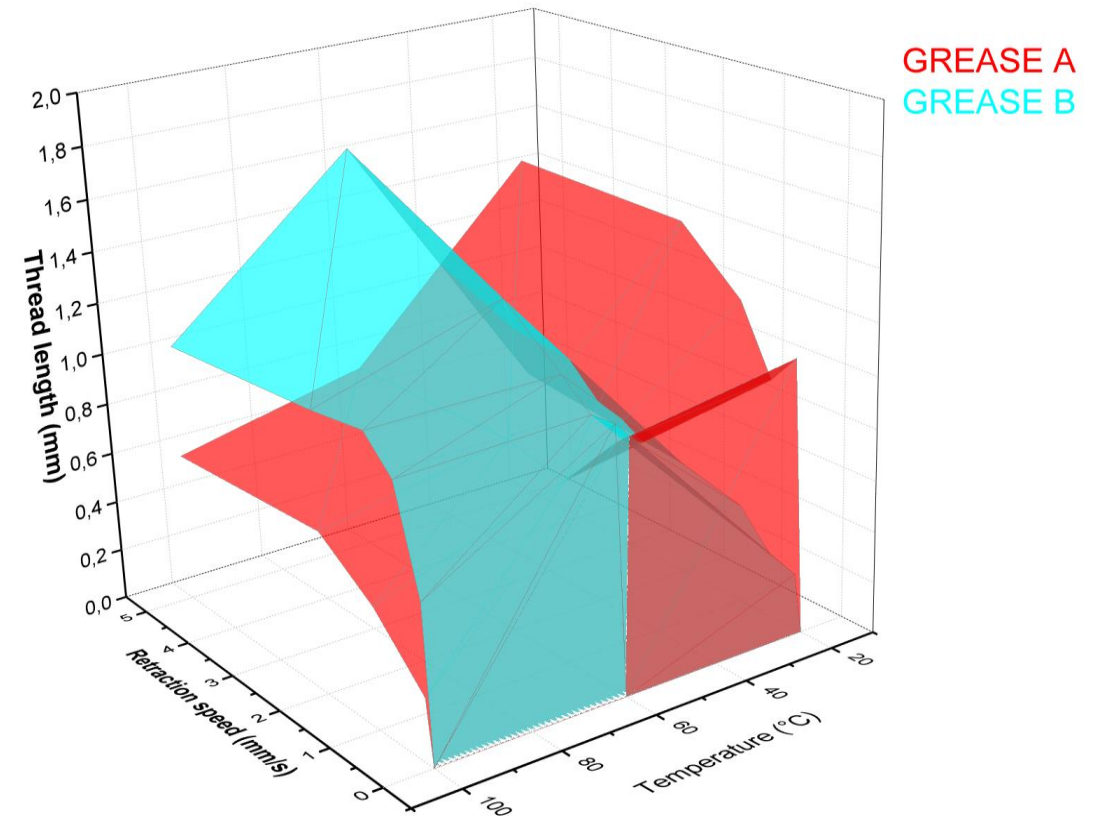
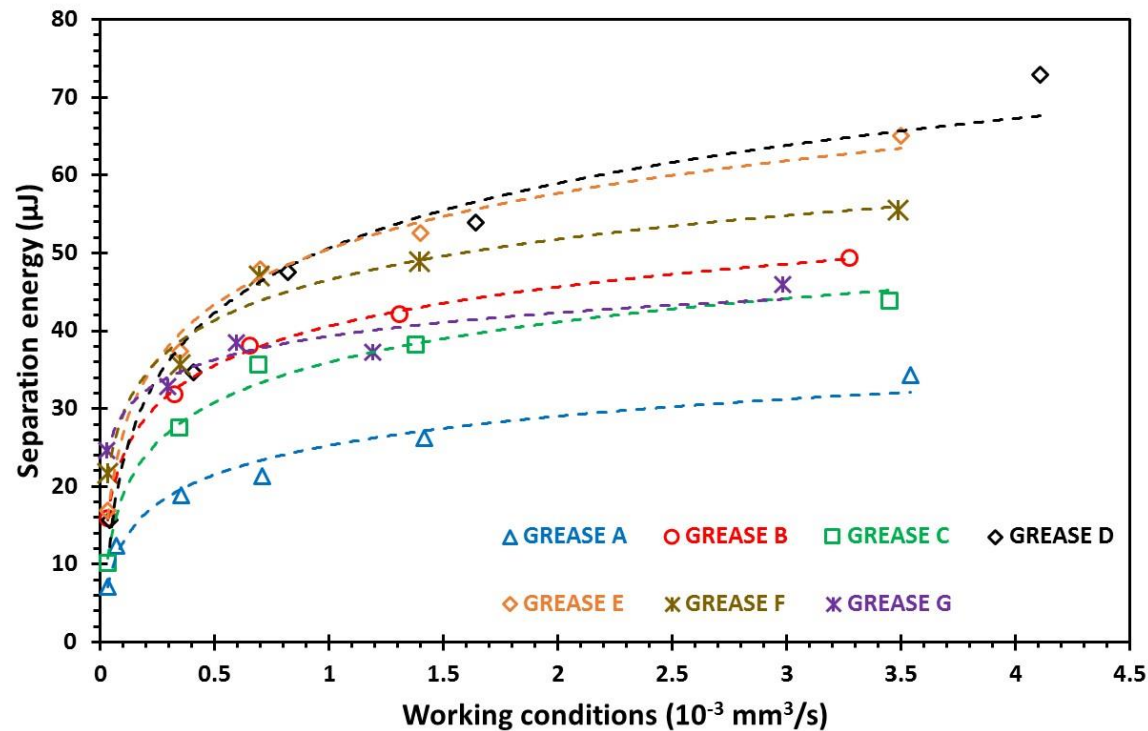


Main conclusions and future aim

Conclusions

- A methodology was developed to measure qualitatively the **adhesion and tackiness** of greases
 - Properties measured: pull-off force, separation energy and thread length
- **Repeatable** measurements were obtained
- **Sensitivity of TAA method** allows to differentiate between different concentrations and types of tackifiers
- Of all parameters measured, **pull-off force** has the **least correlation** to tackiness and thread formation

Future aim



Include tackiness and adhesion in the specifications of industrial greases !

Thank you for your attention

