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Observations on the instrumental measurements of liquid food stickiness

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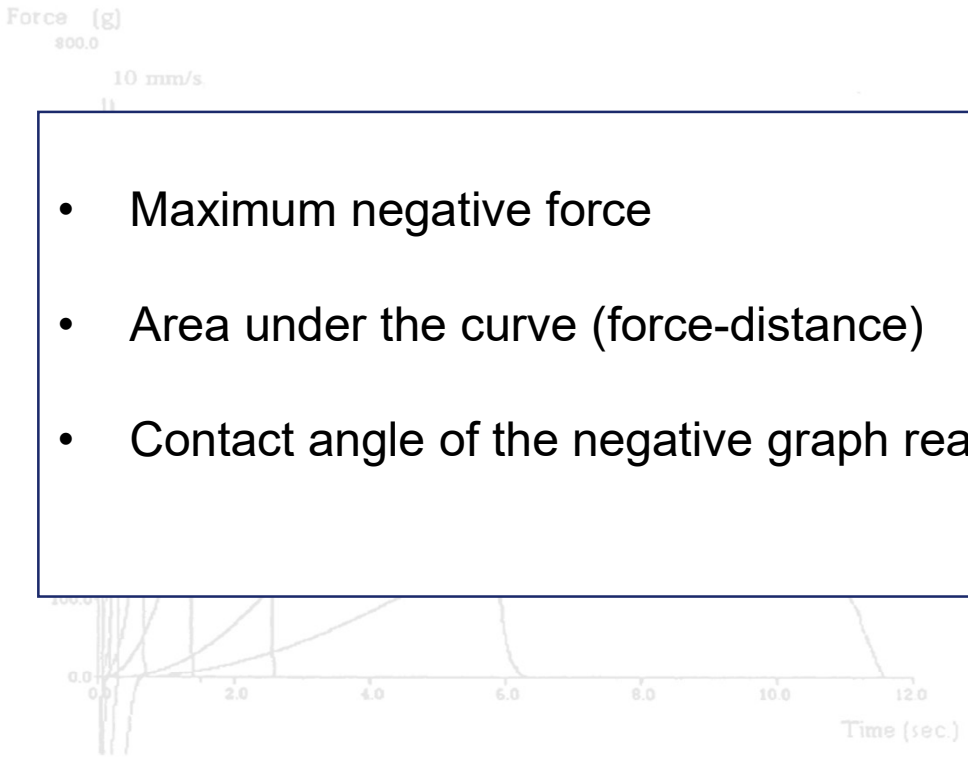
Introduction

- Stickiness is an important characteristic of food materials during food handling and production to consumer perception
- Different instrumental measurements: e.g. peel test, glass transition temperature and probe test or compression test
- In this study, we focus on compression test
- In a compression test, stickiness is defined as “the work necessary to pull the plunger from the sample”

Introduction

Data from a compression test is presented typically as a force-time curve



- Maximum negative force
- Area under the curve (force-distance)
- Contact angle of the negative graph reaching zero value

Typical force time curves of stickiness at different withdrawal speed (adapted from Hoseney and Smewing, 1999)

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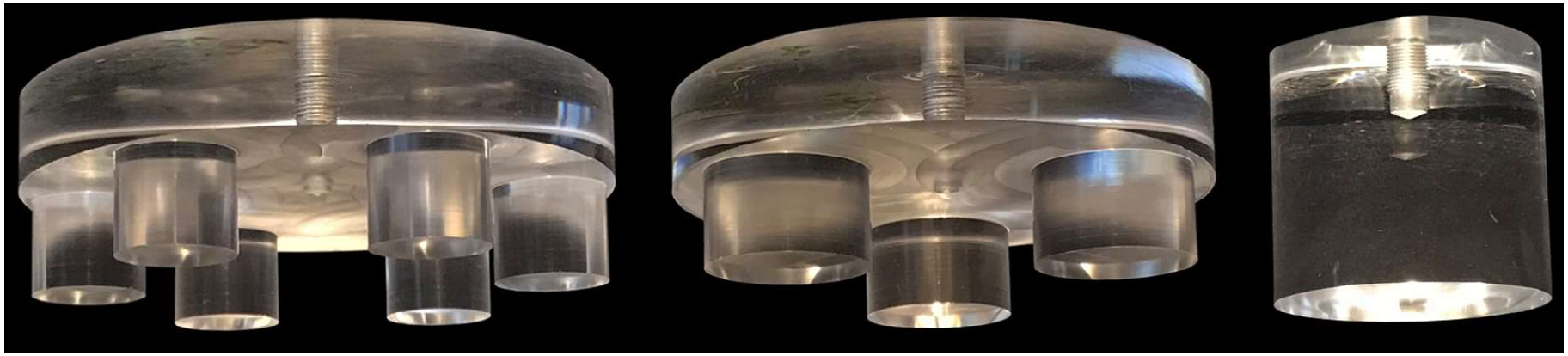
Materials and methods

Single and multi-headed probes were used for experiments



Dimensions of the multi-headed probes

Number of Heads	Diameter of heads (mm)	Total perimeter (mm)	Total contact area (mm²)
1	35.0	110	962
3	20.0	190	962
6	14.0	269	962

A TA.HD texture analyser (Stable Micro Systems) / 5kg load cell

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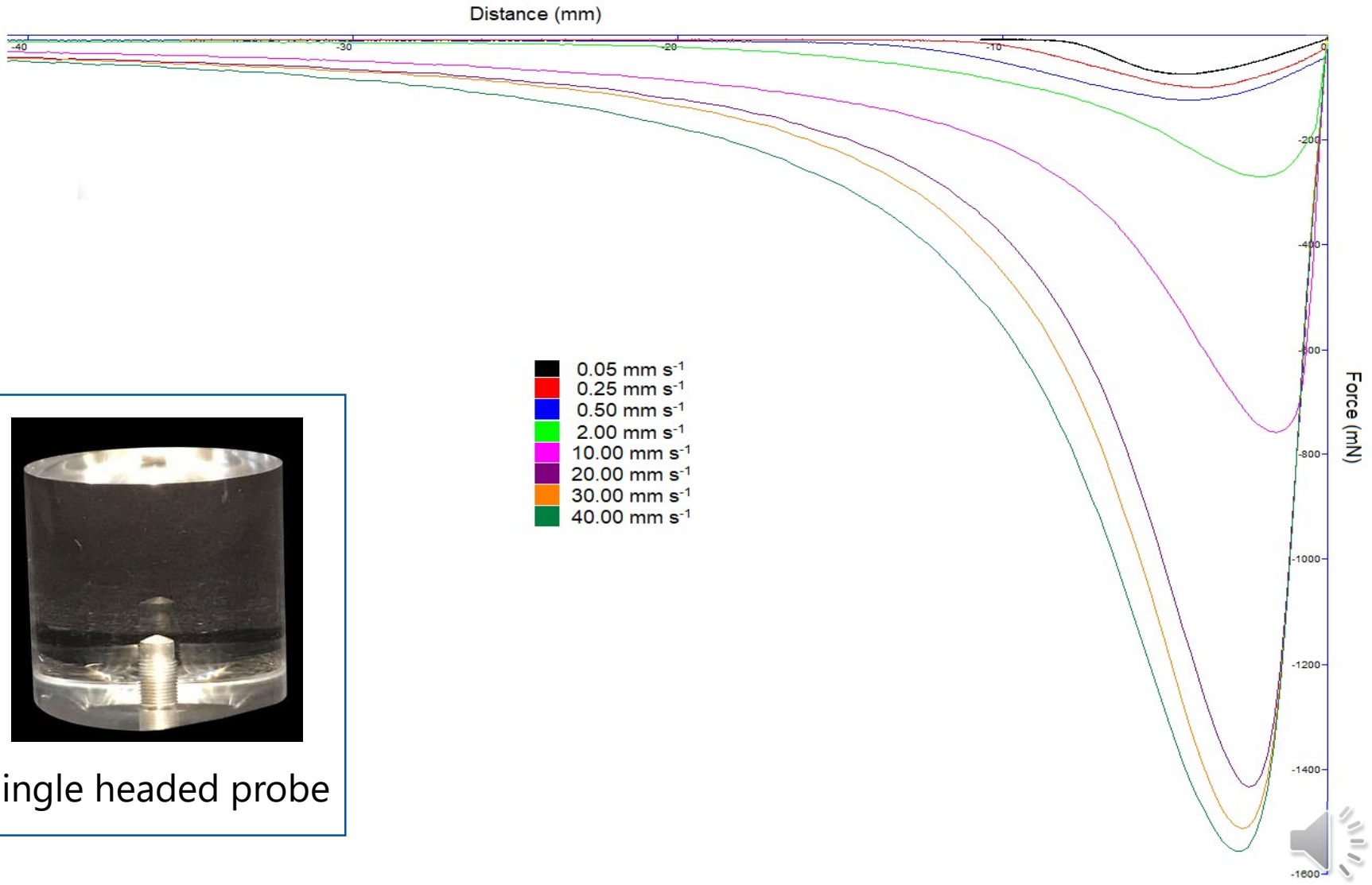
Results and discussion

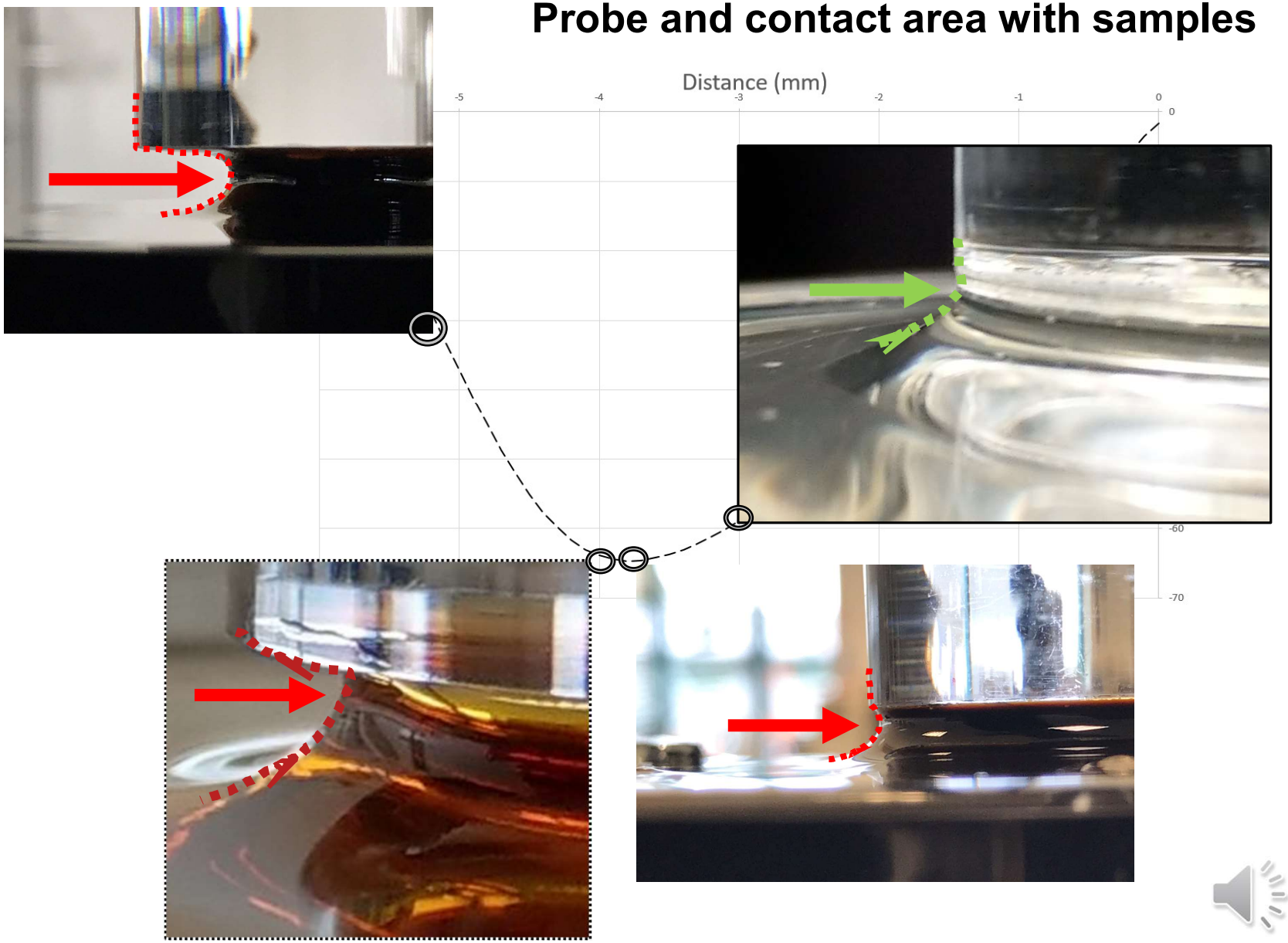
Typical force-distance curves depicting stickiness at different withdrawal speeds



single headed probe

Results and discussion

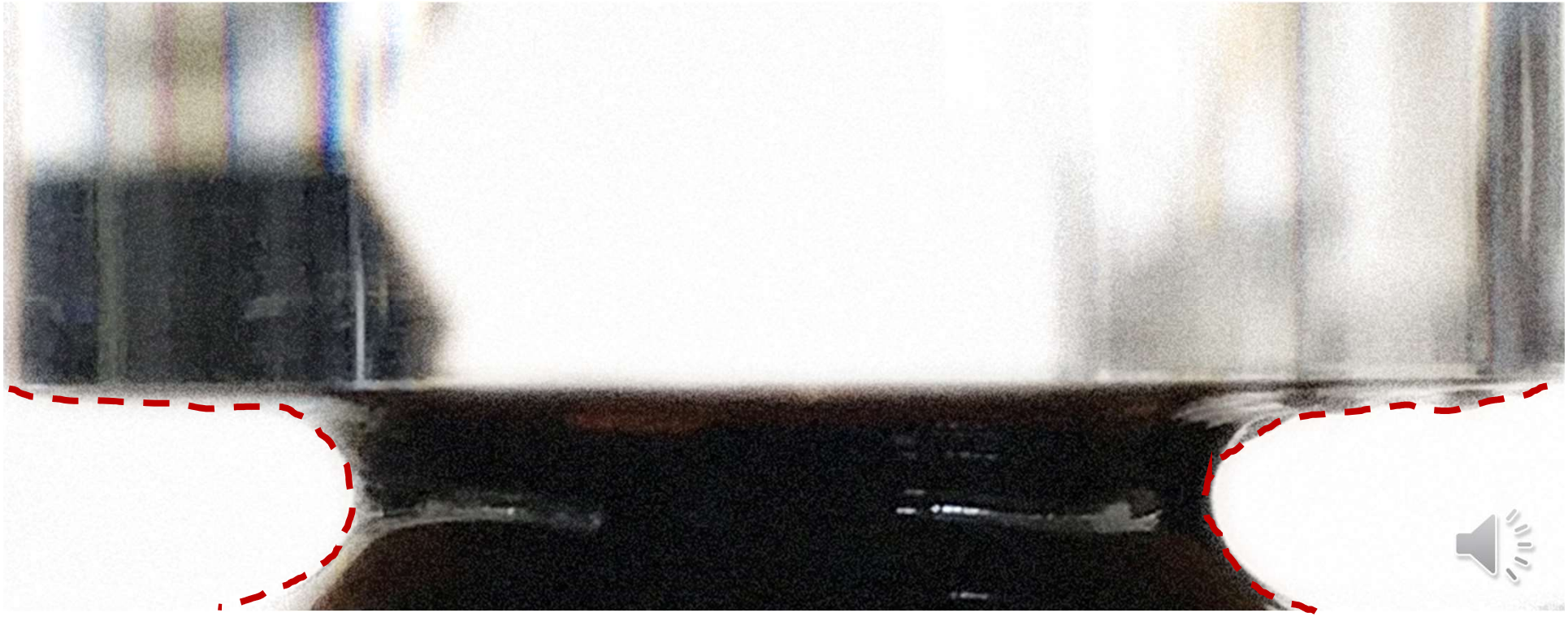
Probe and contact area with samples



Results and discussion

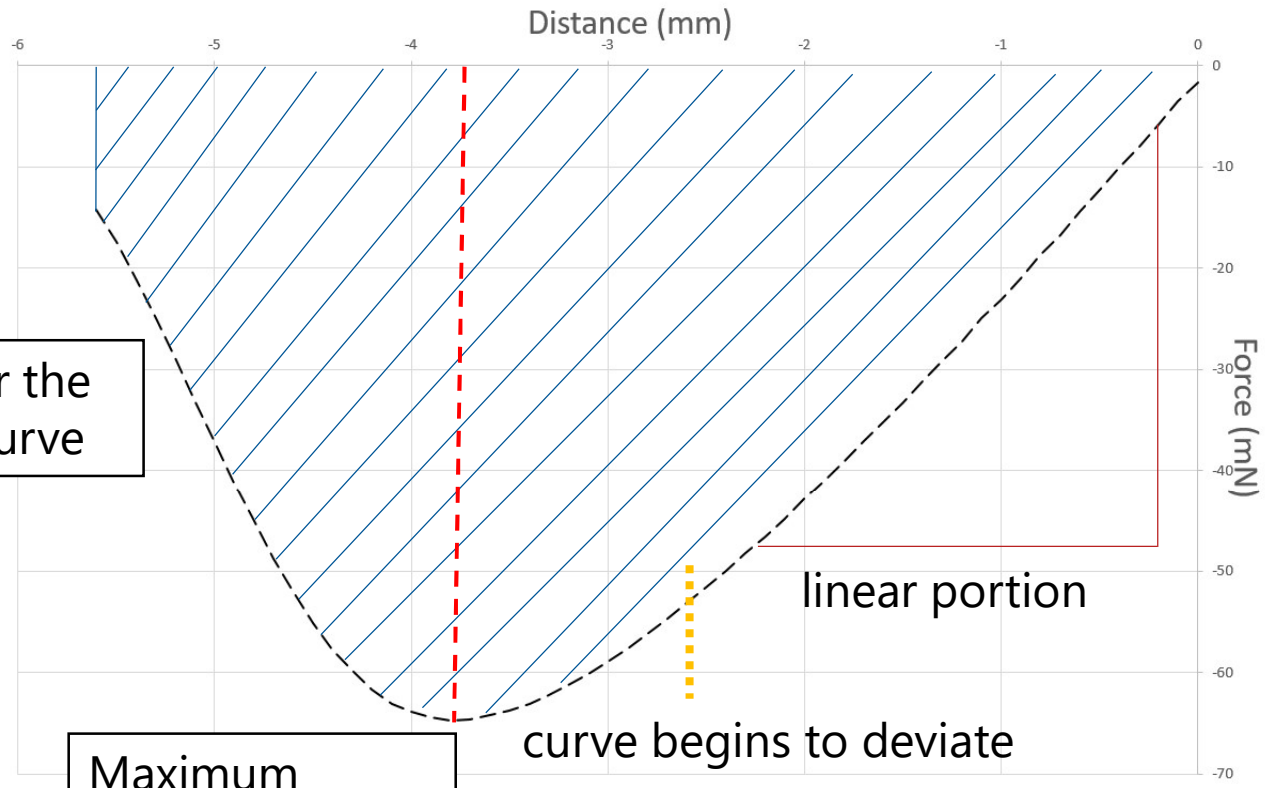
Why is the meniscus so important?

- Contact area
- Pressure difference
- Capillary force
- Viscous force



Results and discussion

A typical curve for the separation of a probe from the surface of a sticky liquid (at a relatively low speed)



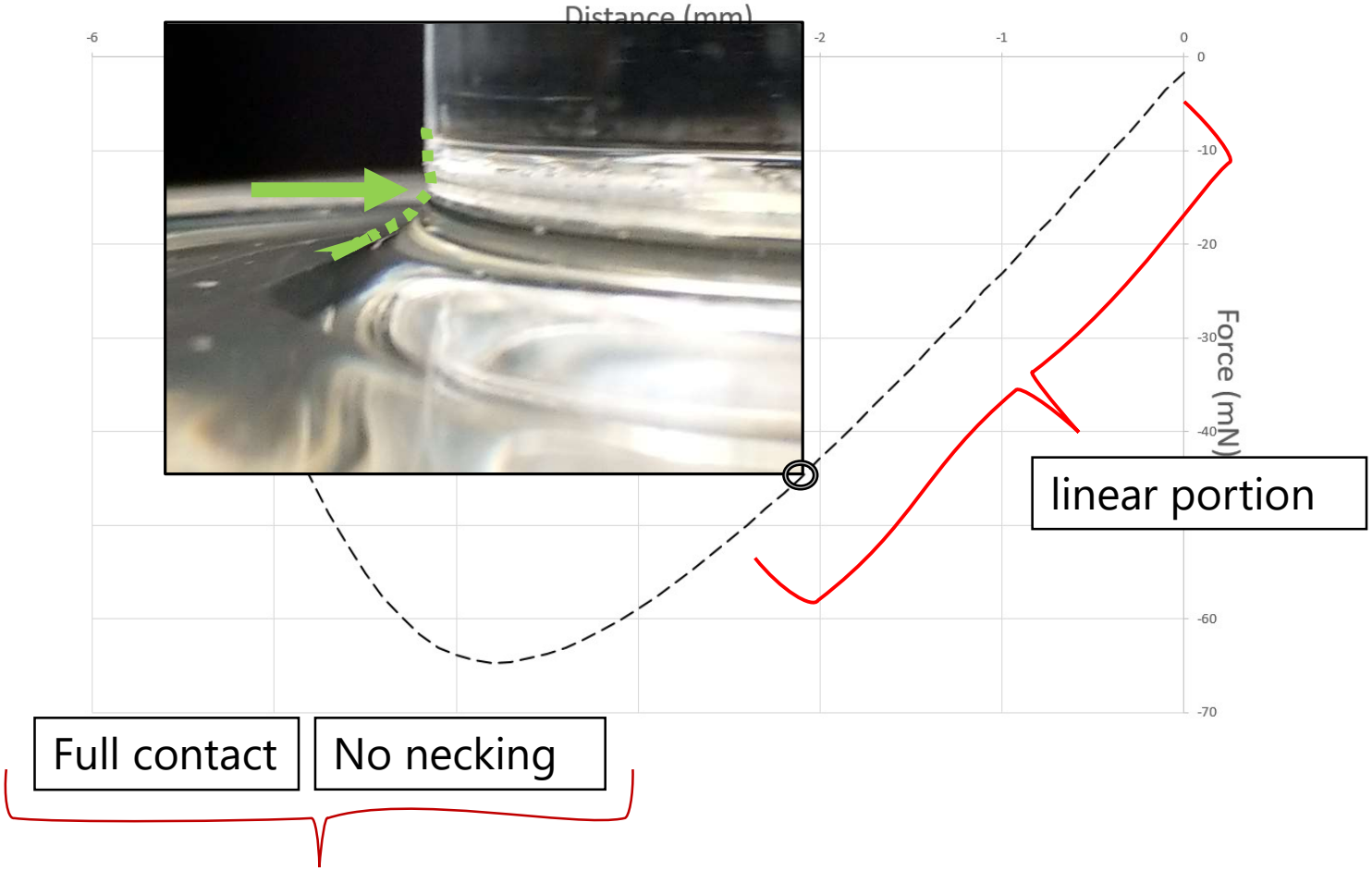
Area under the negative curve

Maximum negative force

Initial gradient of the negative curve

Results and discussion

Initial gradient of the curve as a measure of stickiness



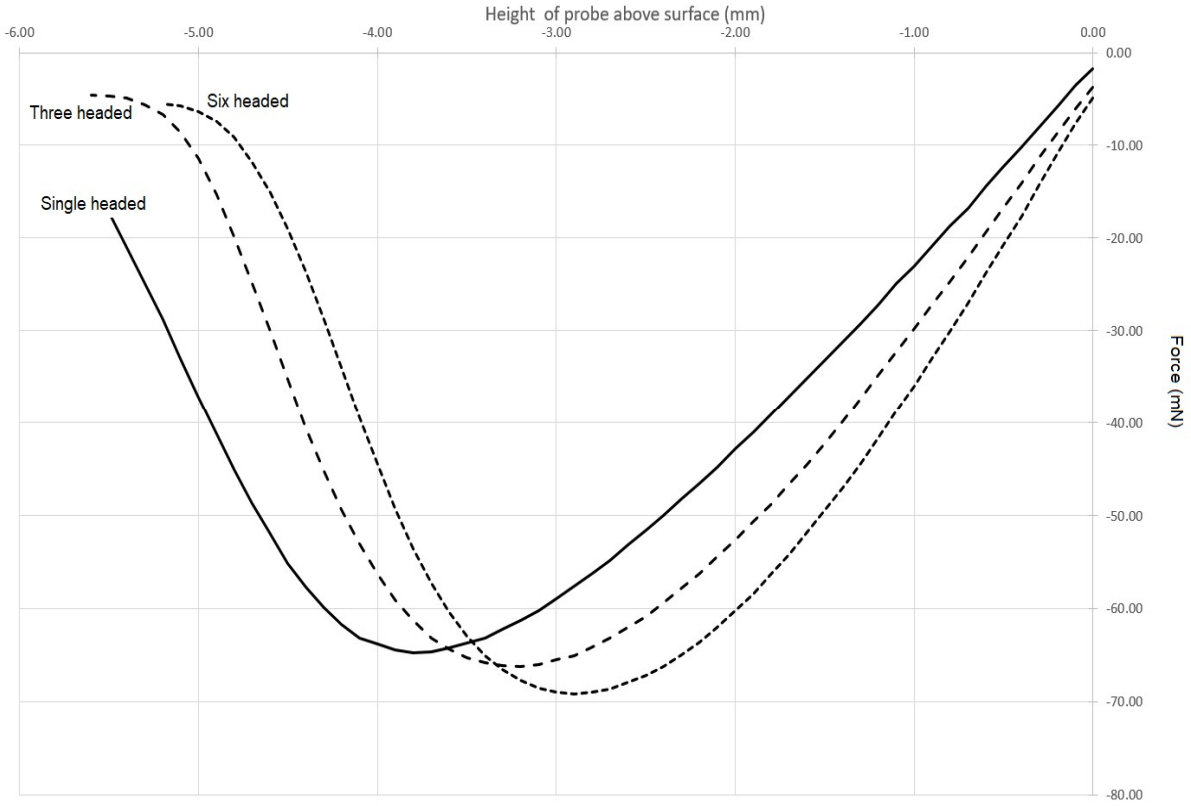
Then the instrumental readings obtained will relate to the contact area of the probe

Results and discussion

Similar basic shape

vs.

slight value differences



Force-Distance curves with constant area (varying perimeter) probes. Probe withdrawal speed is 0.01 mm.s^{-1}

Results and discussion

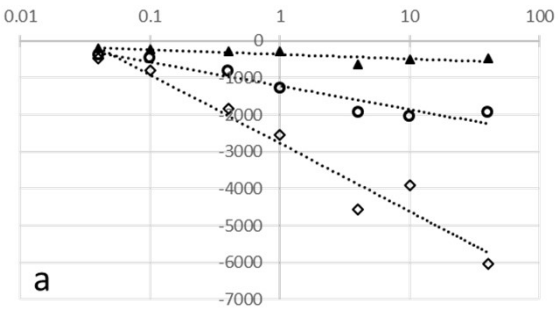
Zero perimeter probe

such a probe does not exist, but:

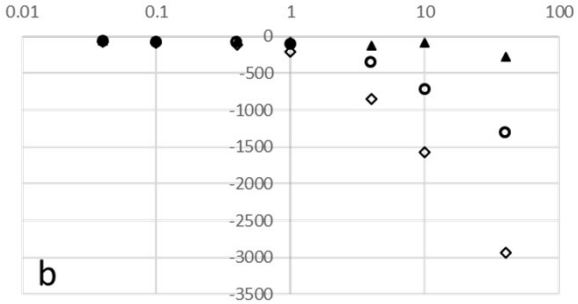
- Force exerted would be solely due to mass of the liquid below probe (in this case, a 962 mm2)
- No annular meniscus region contributing to the extrapolated values obtained
- The nature of the contact angle between the liquid and the probe become irrelevant
- Material of construction of the probe becomes unimportant

Results and discussion

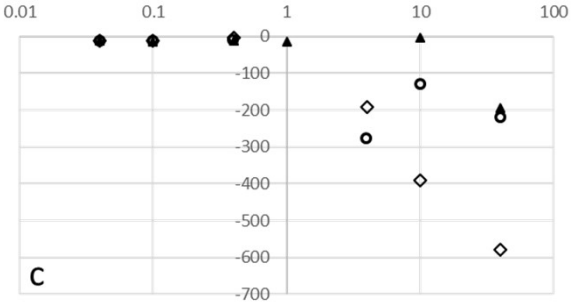
Influence of probe withdrawal velocity on parameters of zero perimeter virtual probe curves
O Golden syrup, ◇ black treacle, ▲ Honey



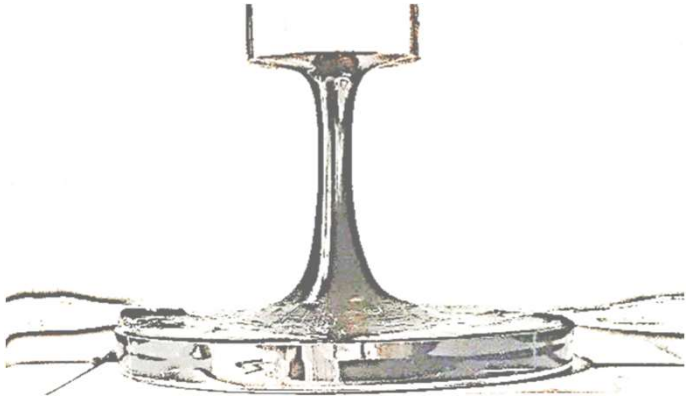
Area under curve



Peak force



Initial gradient



b and c:

- Show a discontinuity
- remaining relatively low at slow speeds and then increasing logarithmically after some critical value which is specific for each liquid.

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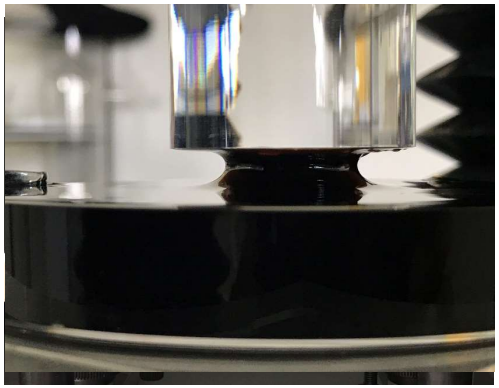
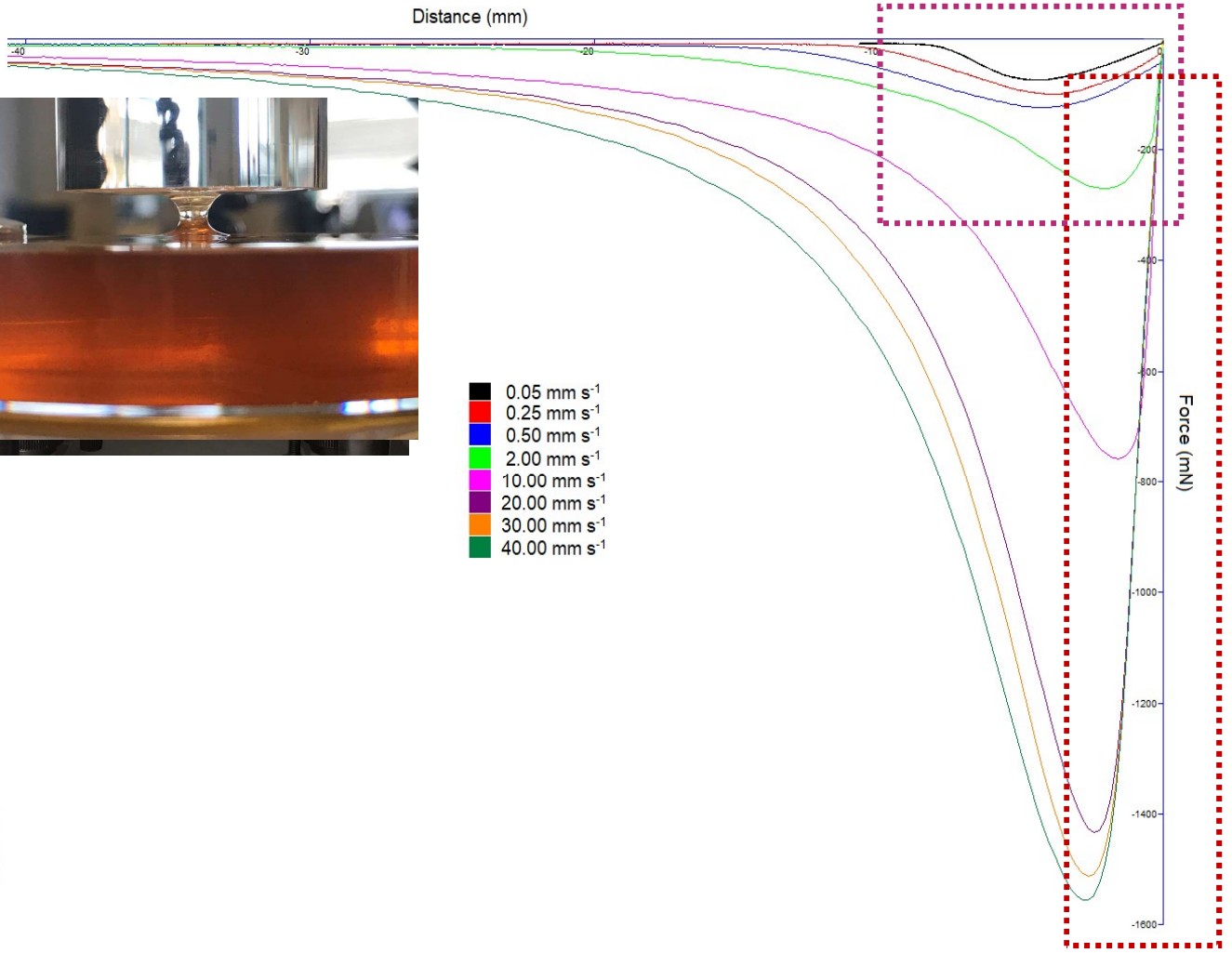
Results and discussion





Liquid has no time to flow back from the probe

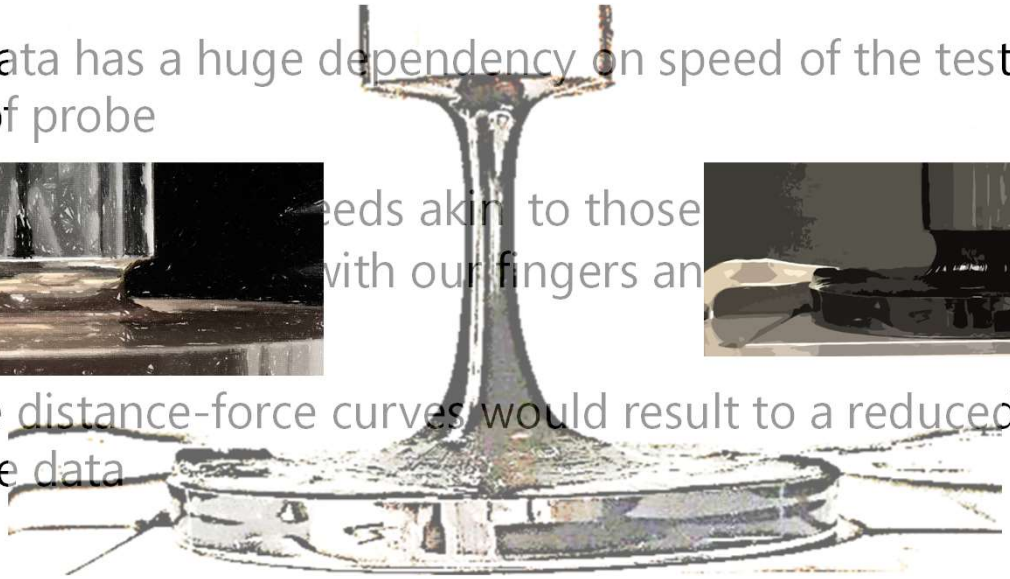
start

Low speed

High speed

Conclusion

- Peak force and the area under the curve are not able to relate the force to the geometry of the probe – not even the zero perimeter virtual probe
- Are the results artefacts of the test method employed ?
- Collected data has a huge dependency on speed of the test and geometry of probe
- eeds akin to those with our fingers an



- Plotting the distance-force curves would result to a reduced effect of the speed of the data
- Our zero perimeter virtual probe overcomes problems with the unpredictable meniscus, necking, probe material and contact angle during the linear part of the curve