

CONTACT CLEANING FOR FUNCTIONAL COATINGS IN EMERGING TECHNOLOGIES

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OUTLINE

- Historical view of contact cleaning
- Current market Drivers
- Science of adhesion
- Surface roughness analysis
- Adhesion measurements
- Other results
- Conclusions

CLEANING FUNDAMENTALS

- Adhesive force between the elastomer roller and the particle must be greater than the force between the particle and the substrate
- The adhesive force between the particle and the adhesive must be greater than that between the elastomer roller and the particle

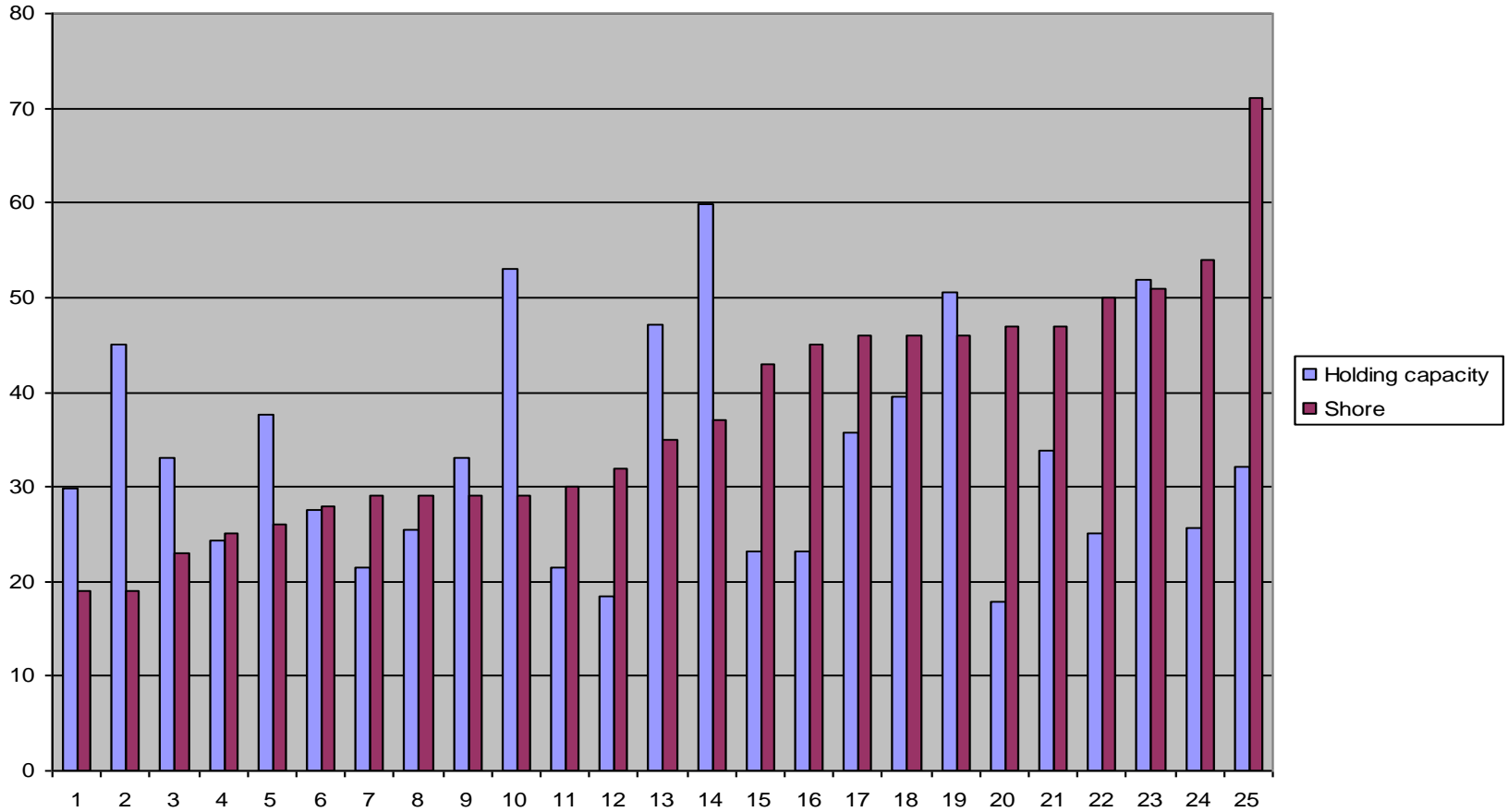
HISTORICAL VIEW

- Softer rollers have greater contact area
- Softer rollers clean better
- Soft rollers deform around particles
- Glossy rollers are smooth
- Smooth rollers clean better

MARKET DRIVERS

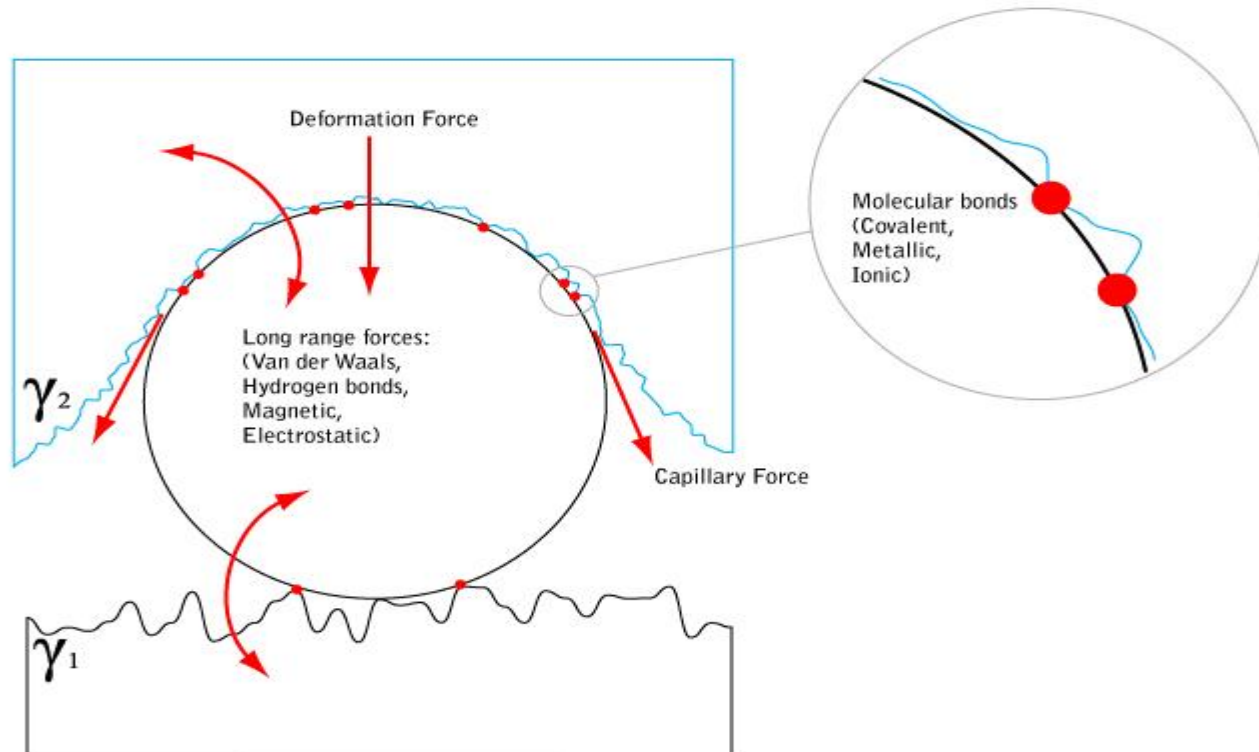
- Thinner films
- Increased processing of sheets
- Specialist functional coatings
- Structured films eg prism films
- Static generative materials
- Unbalanced surfaces

SHORE HARDNESS

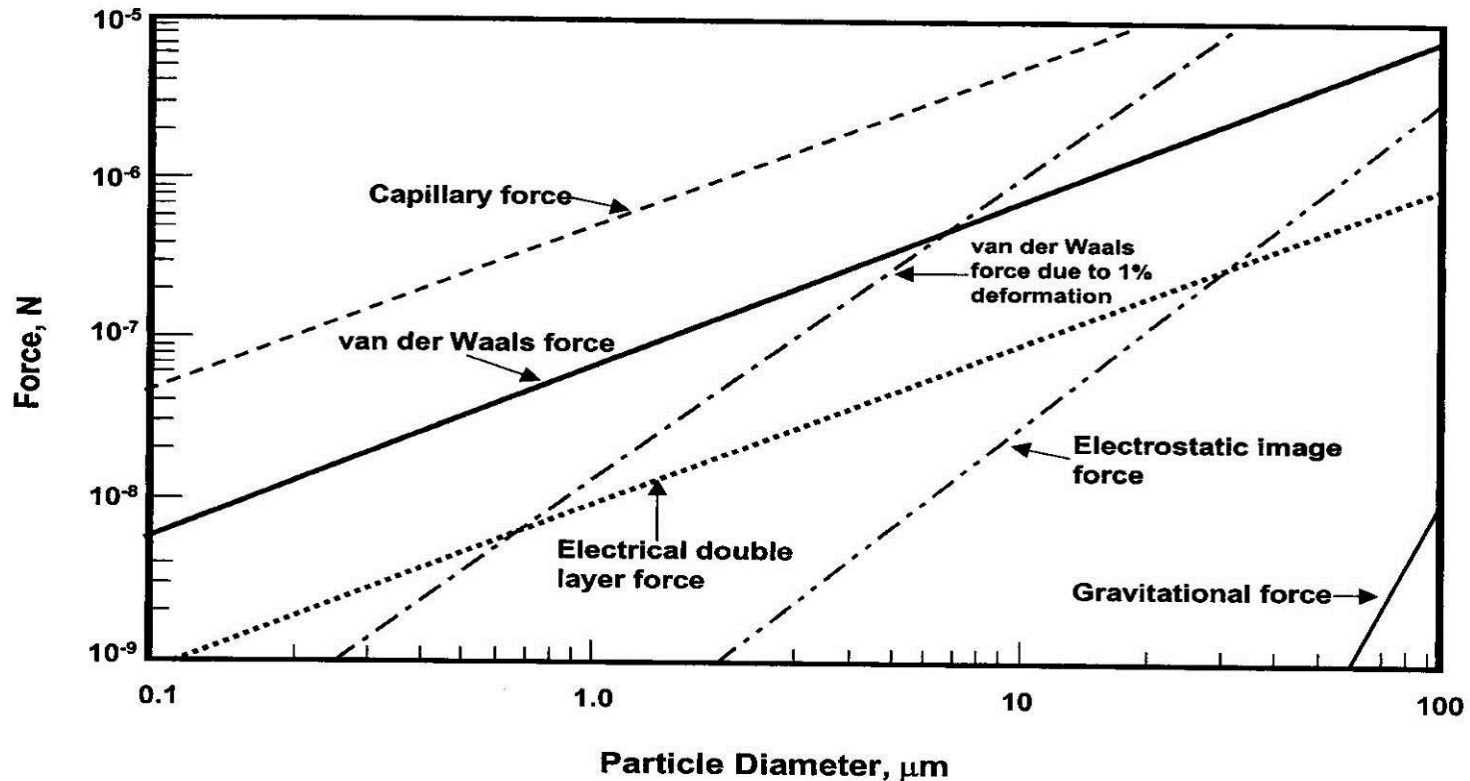


INTERFACIAL FORCES

Constitutive Adhesion Forces



EXAMPLES OF ADHESION FORCES



The adhesion forces are shown as a function of the diameter for an Al_2O_3 particle on a Si substrate [20-21, 37].

MACRO ADHESION

		COPPER	STEEL	Cu/KAPTON	POLYESTER (Gloss)	POLYCARBONATE (Matt)
RUBBER						
SOFT		1.17	3.26	0.51	2.55	2.37
PANEL		1.49	3.32	0.81	2.63	1.07
FILM		0.63	0.81	0.34	1.68	1.4
F3		0.11	0.11	0.11	0.05	0.12
NANO		0.08	0.04	0.07	0.75	0.34

CONTACT AREA

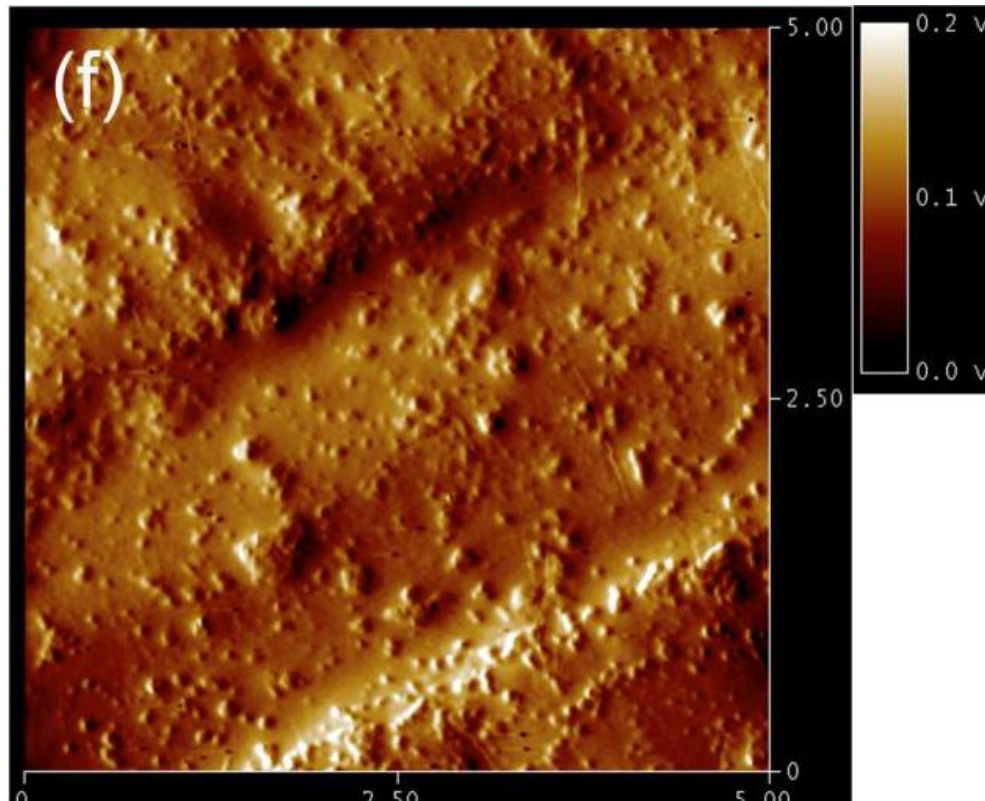
Contact area is impacted by

- Roller surface roughness
- Pressure
- Shore hardness
- Particle morphology

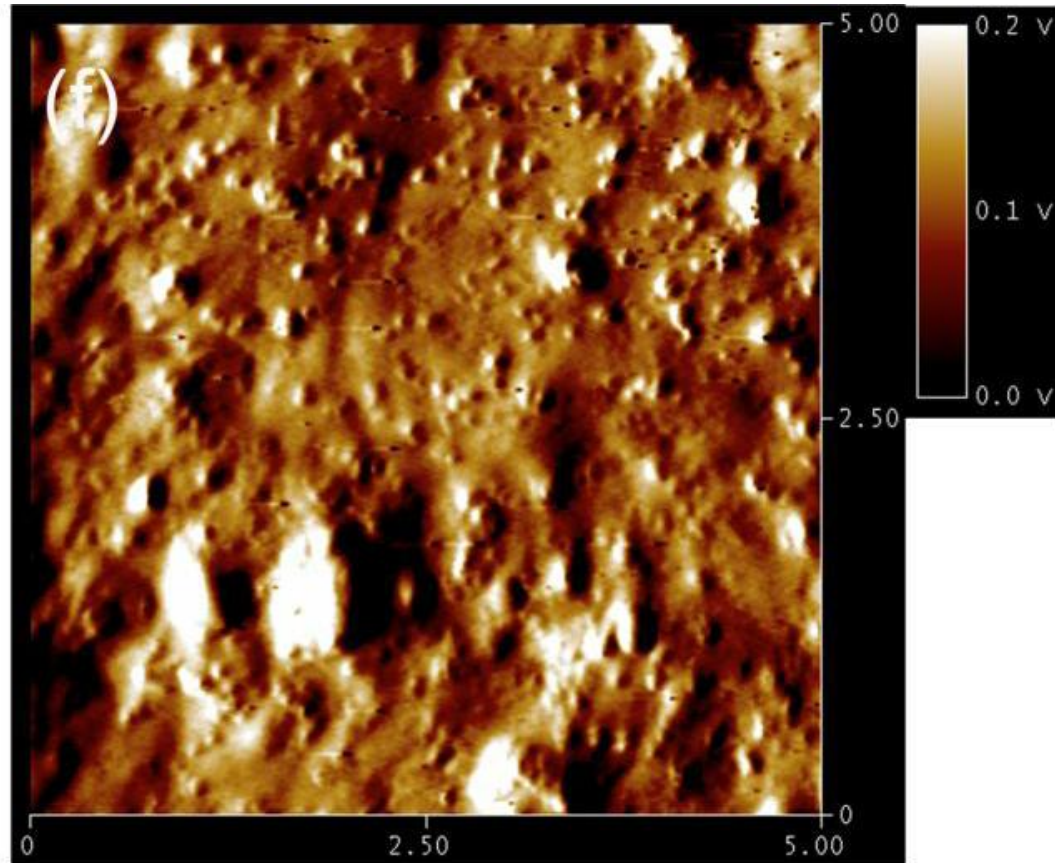
SURFACE ROUGHNESS

Scan Size			
Sample name	1	2	3
Soft	2.169	11.143	38.582
Panel	7.355	13.493	23.467
Nanoclean	3.616	1.400	6.292
Film	7.453	16.861	18.54
F3	31.009	49.085	98.334

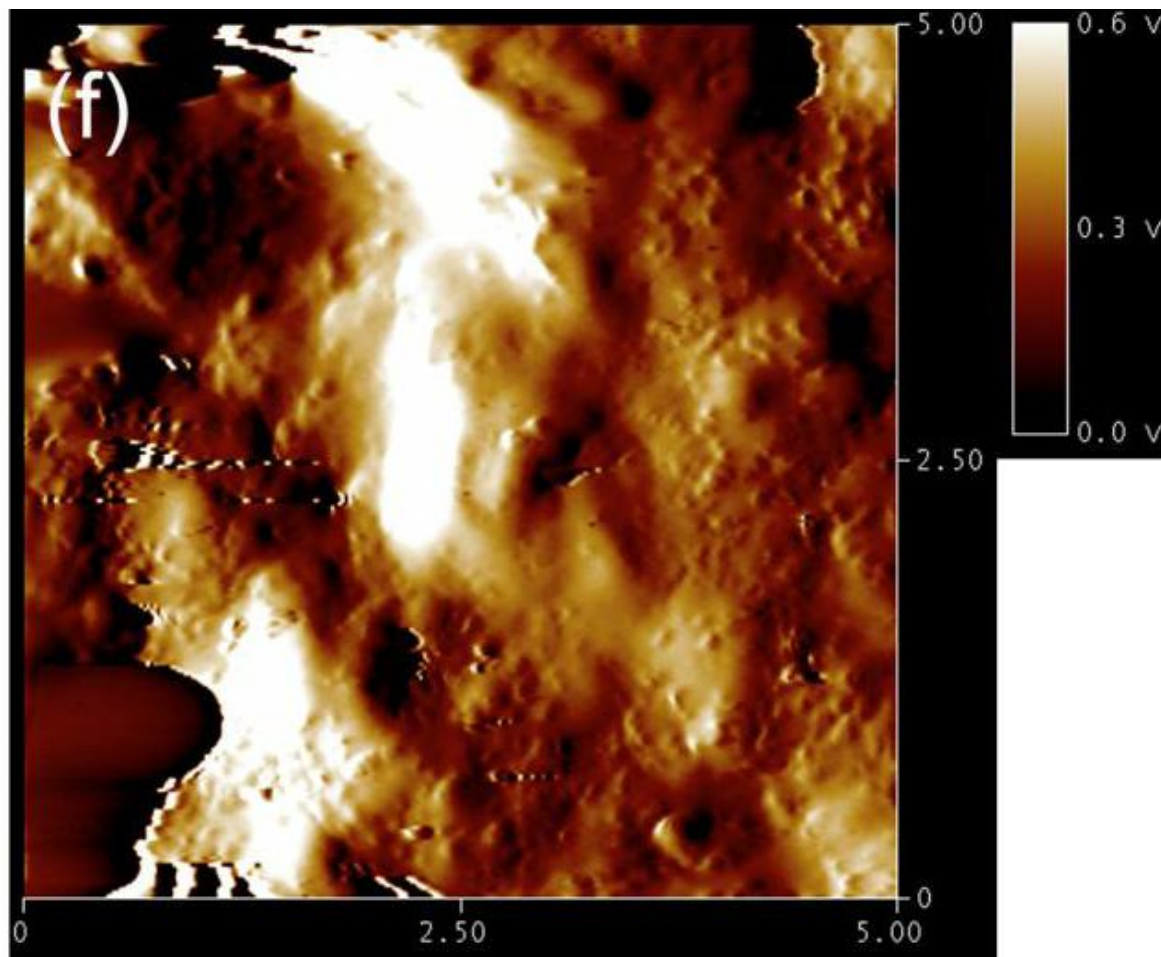
SURFACE OF SOFT ELASTOMER



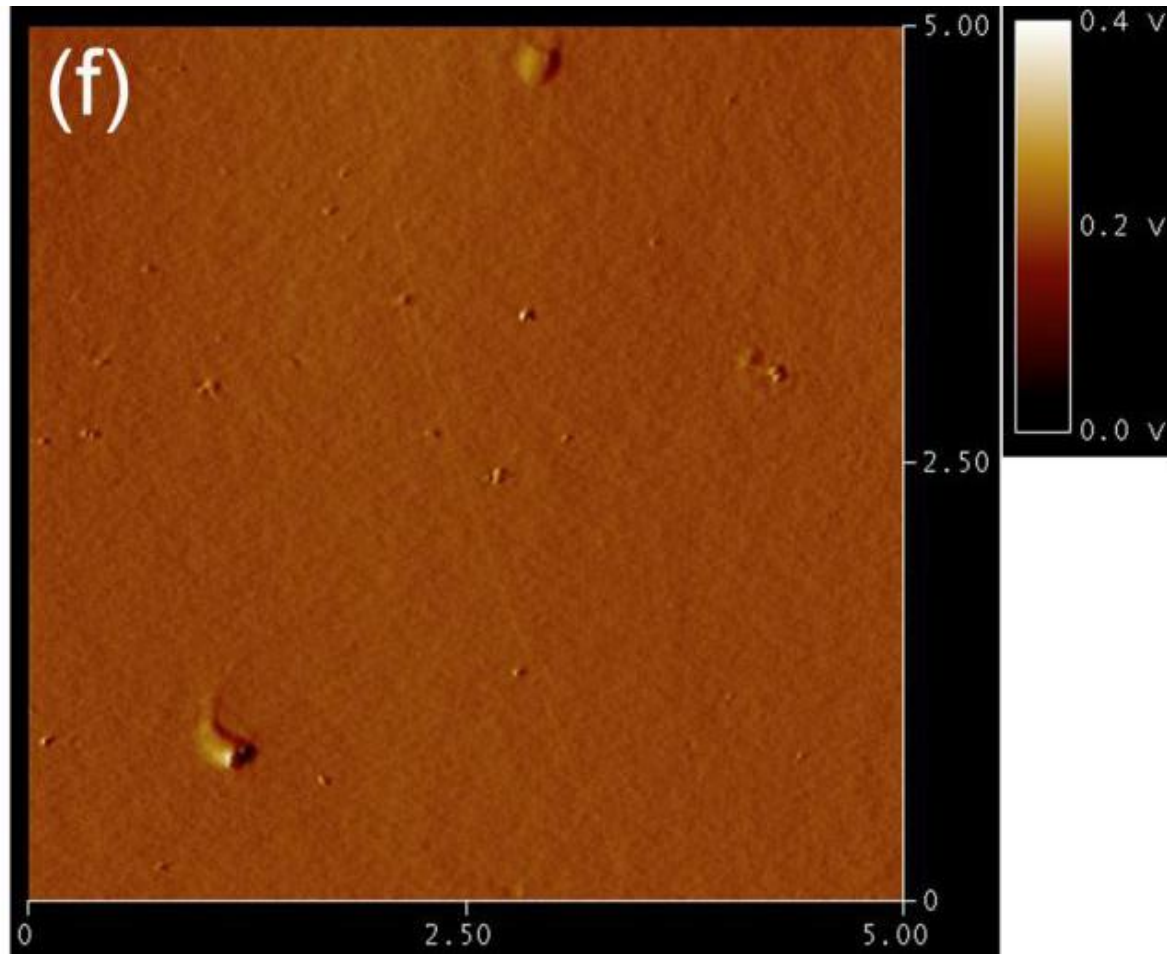
SURFACE OF PANEL ELASTOMER



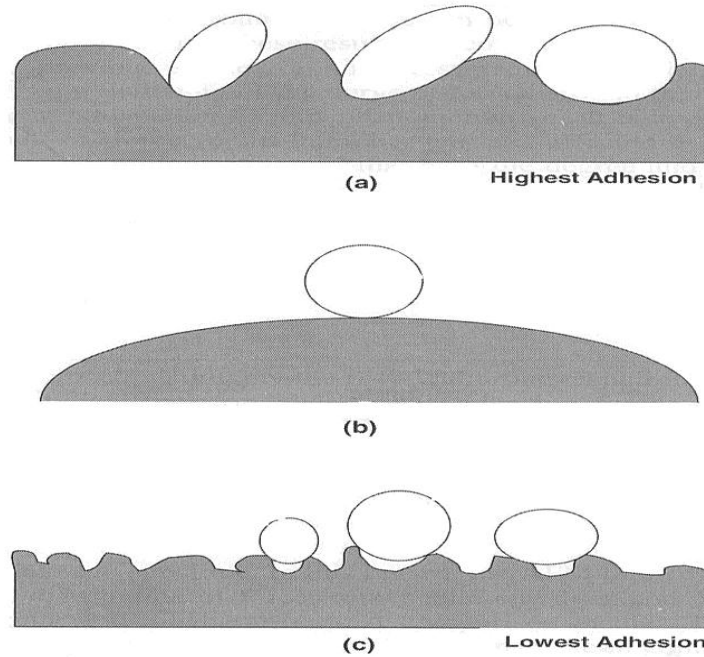
SURFACE OF F3 ELASTOMER



SURFACE OF NANOCLEEN ELASTOMER



SURFACE ROUGHNESS



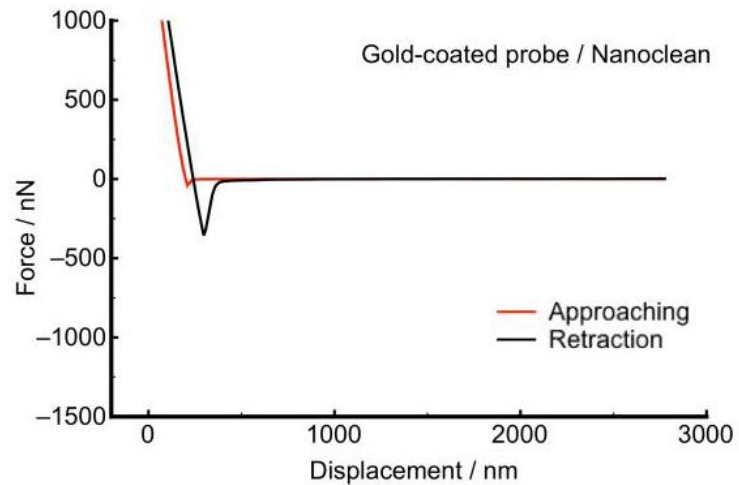
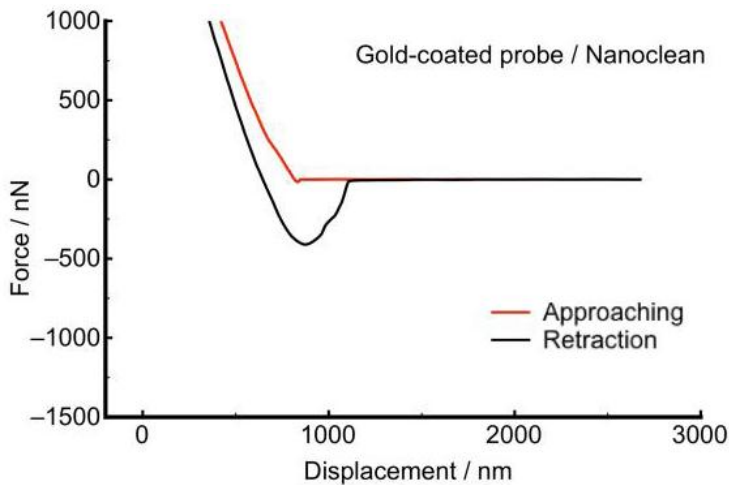
The effect of roughness on adhesion forces. Micrometer roughness (a) increases the adhesion due to increased contact area. The adhesion forces are higher in (b) than are present in (c) because there is a larger contact area and, therefore, larger van der Waals forces. Nanoscale roughness (c) reduces the contact area and the resulting adhesion force.

SUMMARY

- For small particles surface roughness has to be considered on a microscopic scale
- Ideally surface asperities should be matched to the size of the particle of contamination
- The flexibility of the roughness peaks is important.

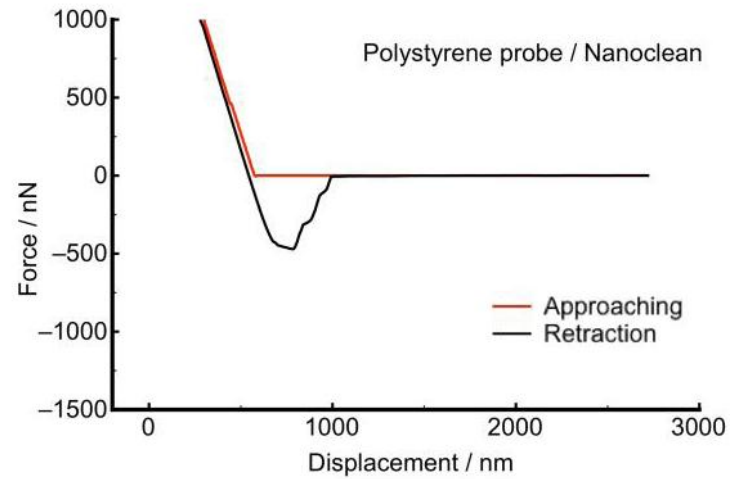
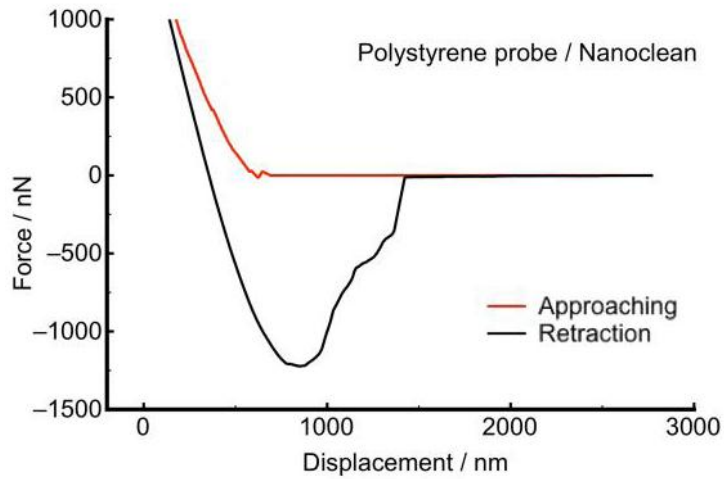
FORCE DISPLACEMENT CURVES

- Gold



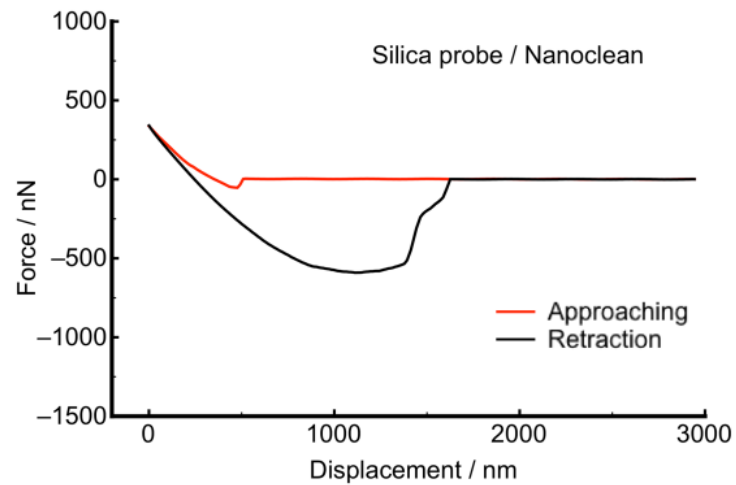
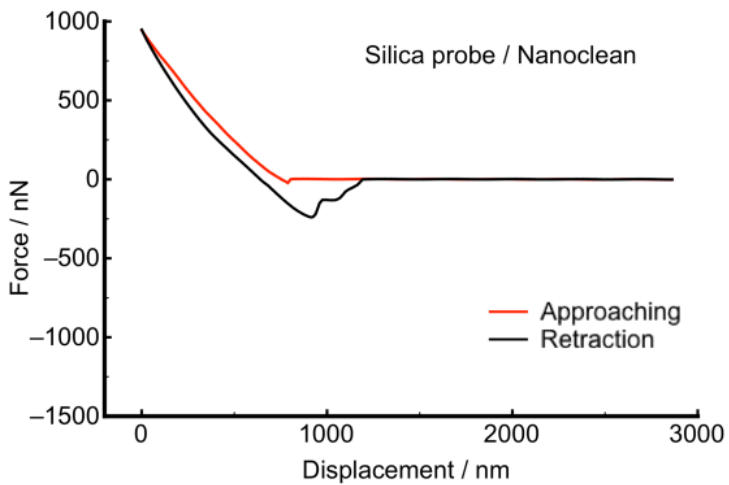
FORCE DISPLACEMENT CURVES

- Polystyrene



FORCE DISPLACEMENT CURVES

- Silica

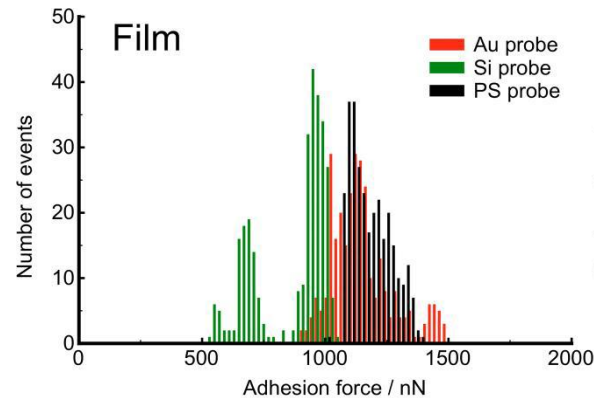
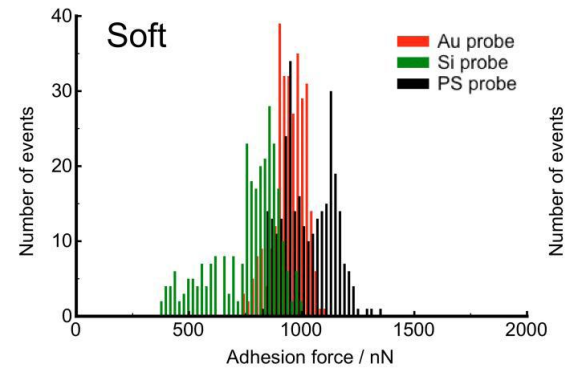
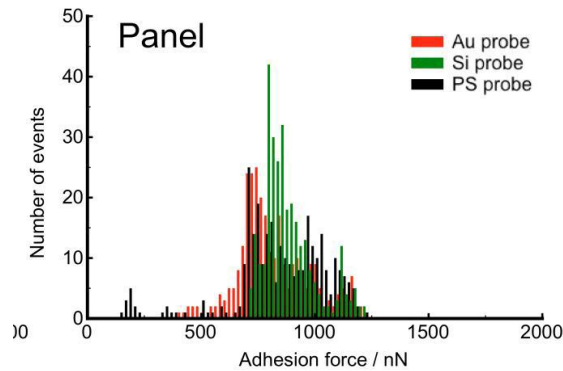


ADHESION FORCES

Type of Probe Sample name	Silica	Gold-coated silica	Polystyrene
Soft	752.08±147.06	951.87±69.48	1027.79±109.82
Panel	848.11±112.98	823.55±160.72	847.12±214.75
Nanoclean	803.08±443.79	285.14±161.34	1073.17±629.94
Film	866.80±144.75	1152.12±125.74	1177.89±81.77
F3	1076.98±420.92	746.64±329.49	813.09±393.31

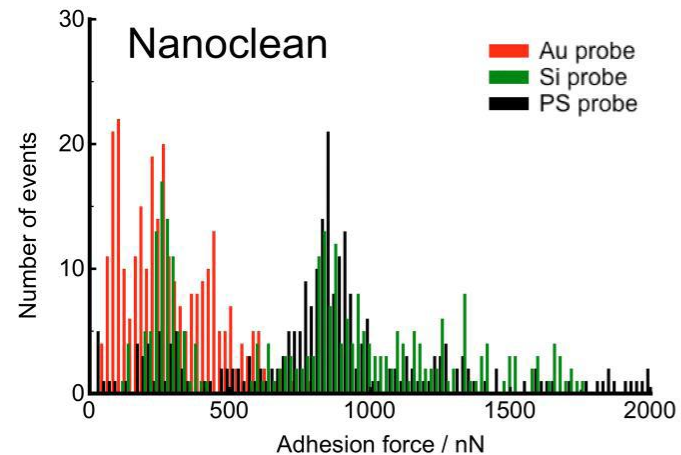
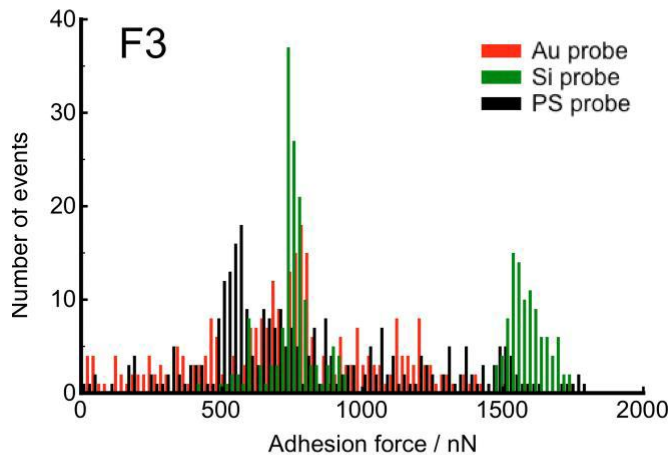
ADHESION FORCES

- Panel and soft and film



ADHESION FORCES

- F3 and Nanoclean



SUMMARY

- Hydrophobicity of materials is important for adhesion
- Adhesion on the macro scale does not relate to the micro scale
- Surface roughness on a micro scale causes variations in the adhesion forces

CONCLUSIONS

- Moisture affects cleaning performance
- Good cleaning improves wettability
- Lot more experimentation required

ACKNOWLEDGEMENTS

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