CONTACT CLEANING FOR BARRIER COATINGS

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OUTLINE

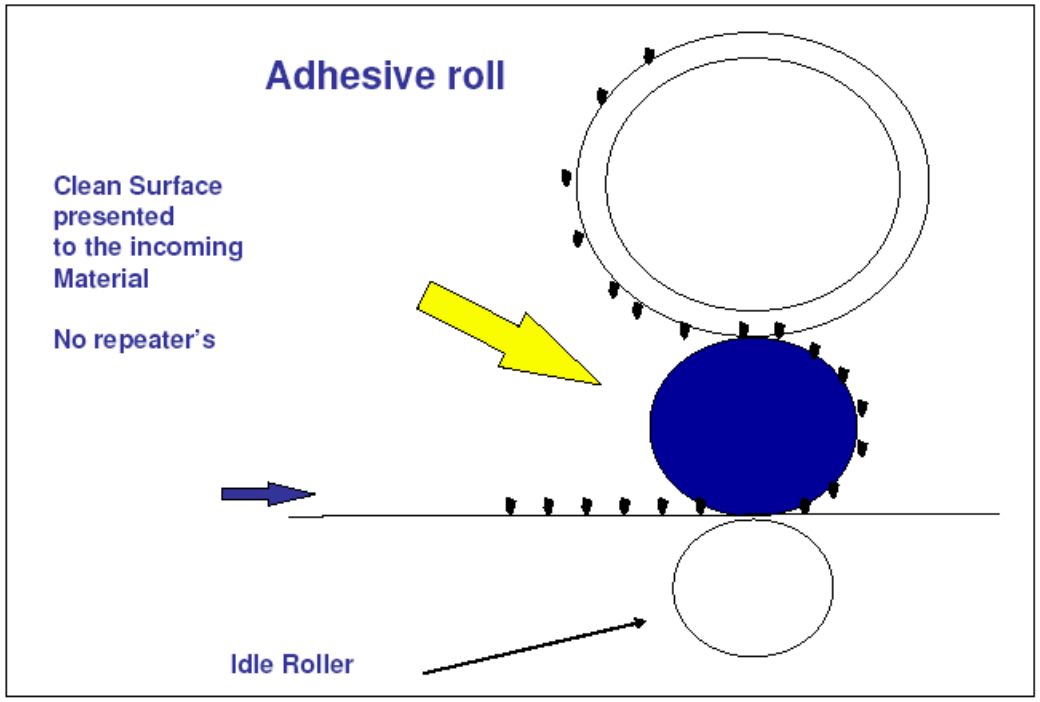
- Current market Drivers
- What is Contact Cleaning
- How does contact cleaning work
- Science of adhesion
- Surface roughness analysis
- Adhesion measurements
- Contact Cleaning in a vacuum
- Conclusions

MARKET DRIVERS

- Requirement for increased lifetimes in OLEDs and OPV
- Increasing use of Organic functional coatings which are moisture sensitive
- Thinner coatings
- Thinner films
- Static generative materials

HOW IT WORKS

Figure 1: Contact Cleaning Mechanism

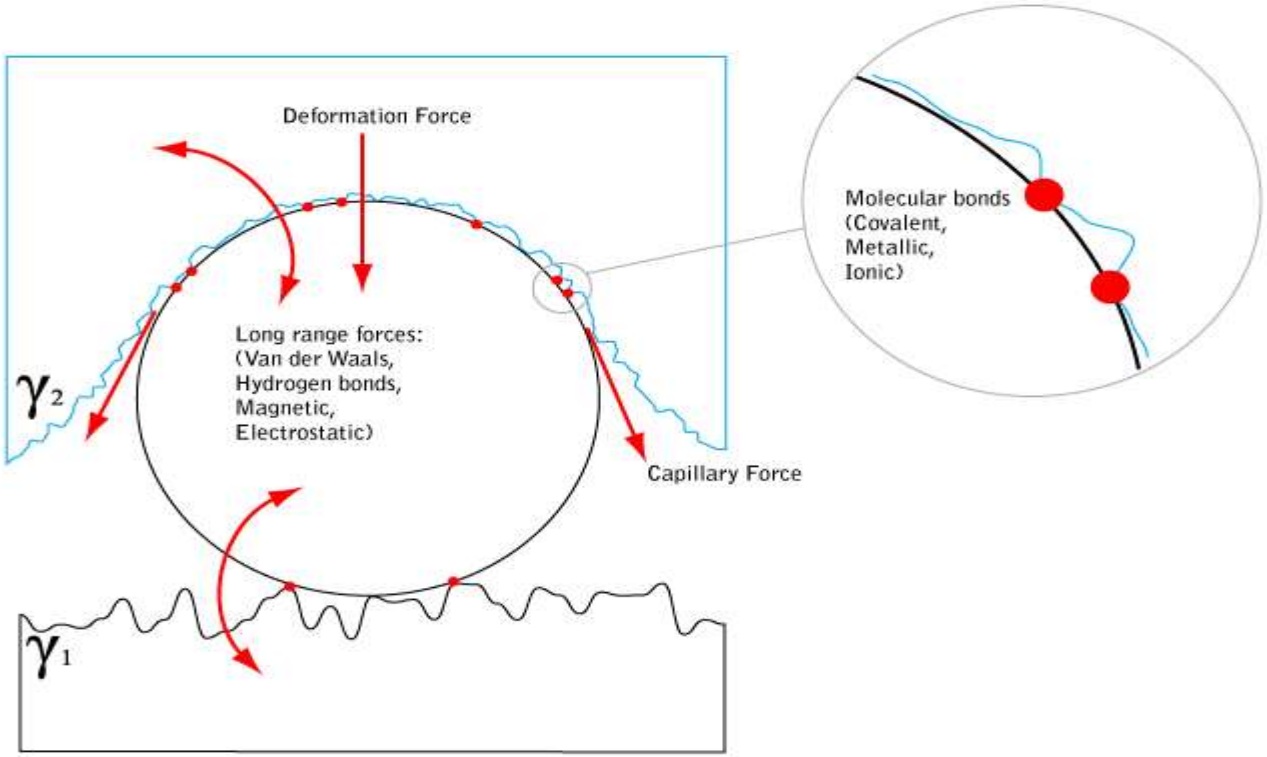


CLEANING FUNDAMENTALS

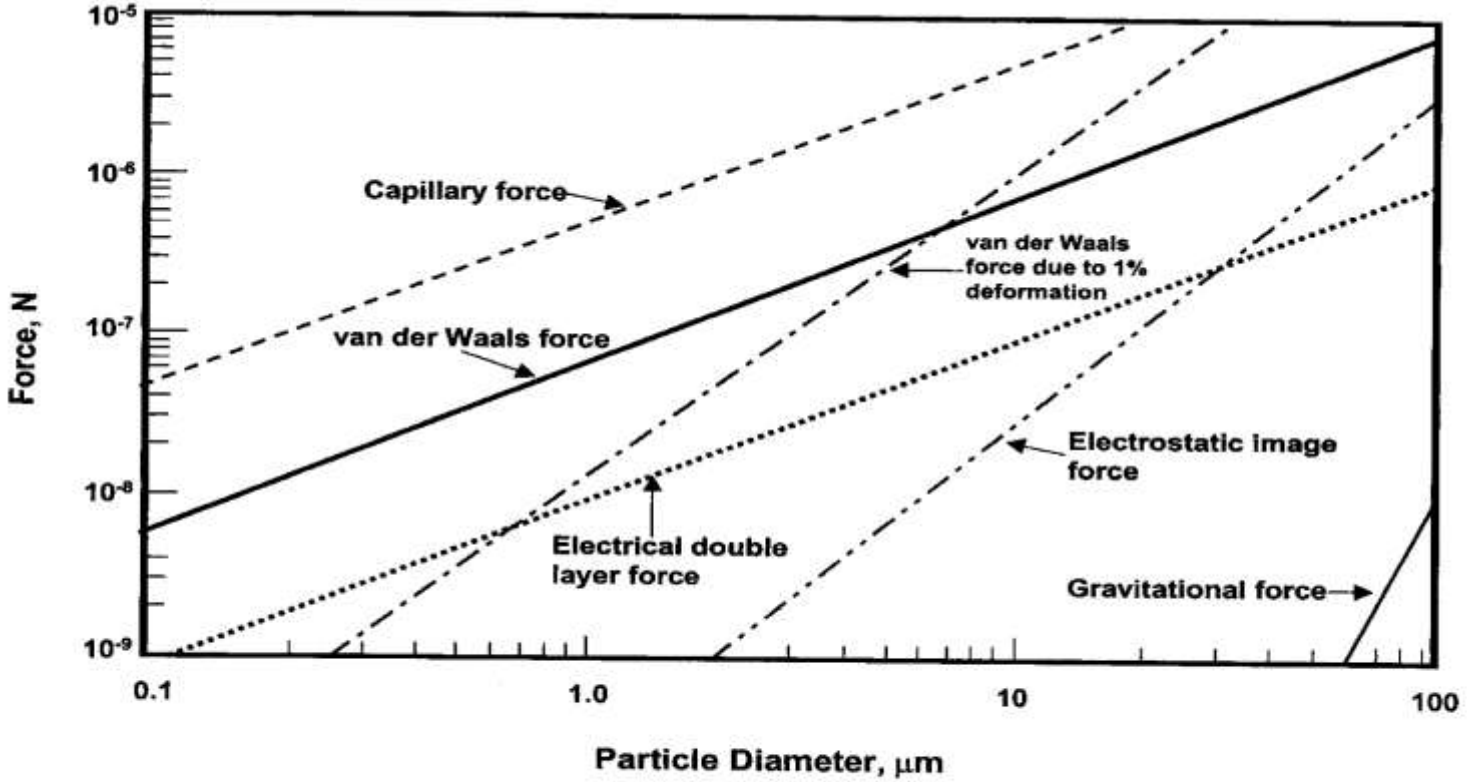
- Adhesive force between the elastomer roller and the particle must be greater than the force between the particle and the substrate
- The adhesive force between the particle and the adhesive must be greater than that between the elastomer roller and the particle

INTERFACIAL FORCES

Constituitive 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

RUBBER		COPPER	STEEL	Cu/KAPTON	POLYESTER (Gloss)	POLYCARBONATE (Matt)
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

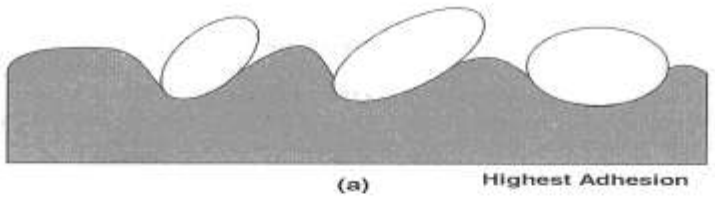
Contact area is impacted by

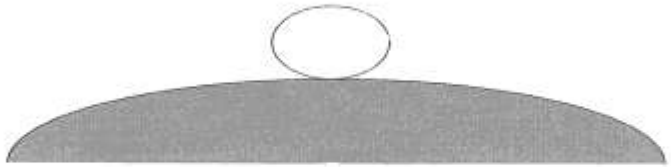
- Roller surface roughness
- Pressure
- Shore hardness
- Particle morphology

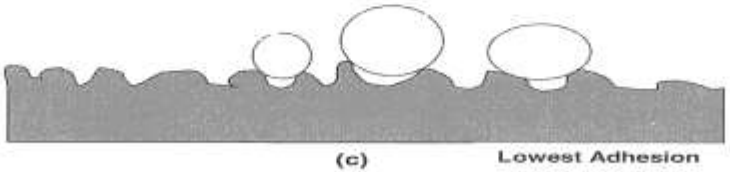
SURFACE ROUGHNESS

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 ROUGHNESS

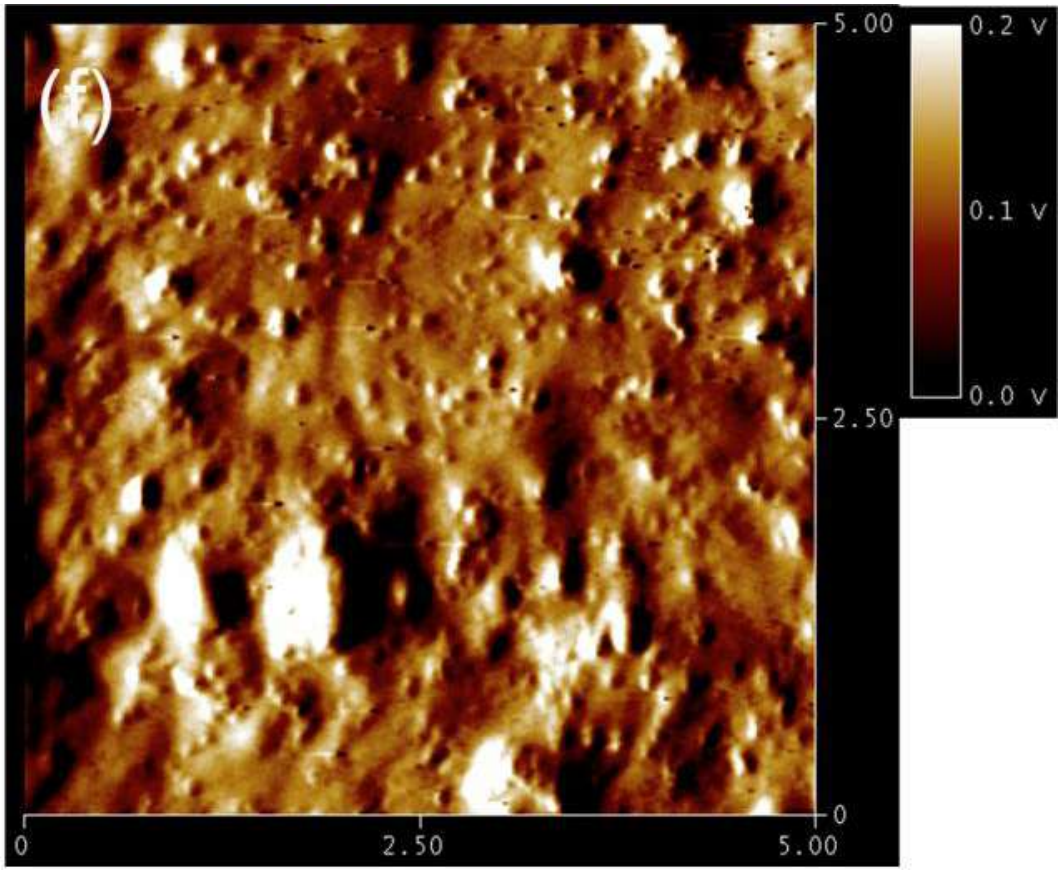




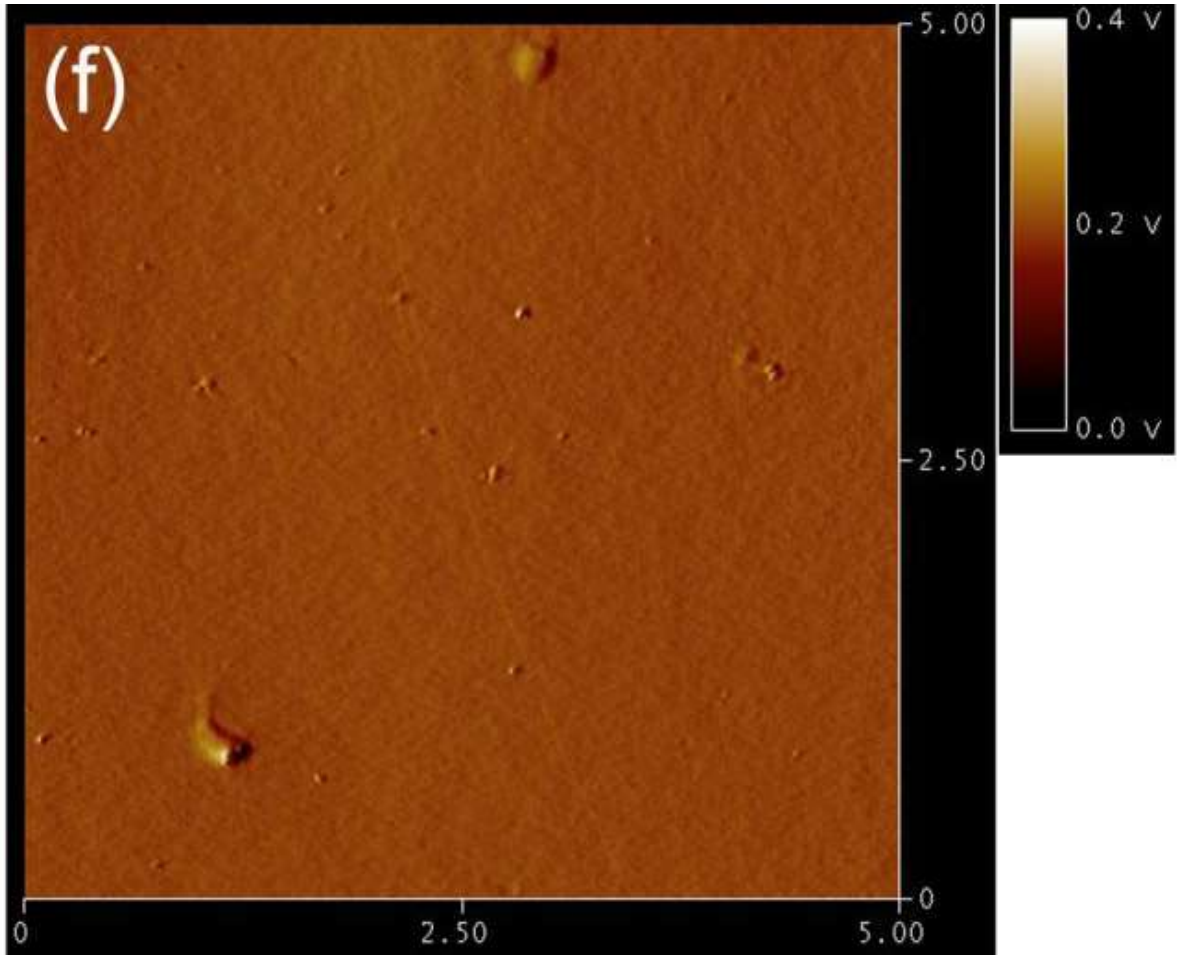


The effect of roughness on adhesion forces. Micrometer roughness (a) increases the adhesion due to increased contact area. The adhesion forces are higher in (b) than are present in (c) because there is a larger contact area and, therefore, larger van der Waals forces. Nanoscale roughness (c) reduces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

SURFACE OF PANEL ELASTOMER



SURFACE OF NANOCLEEN ELASTOMER

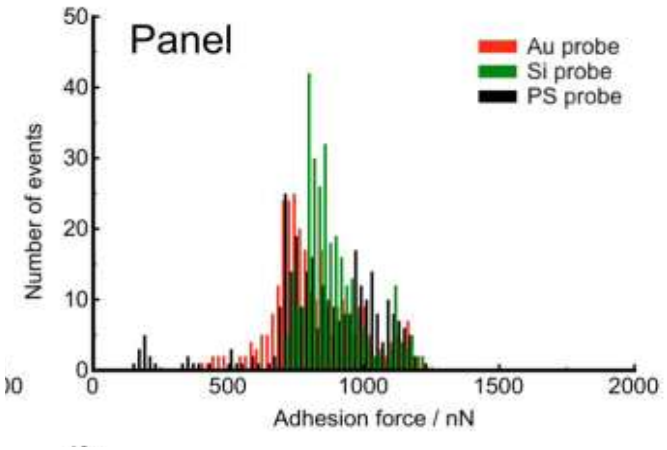


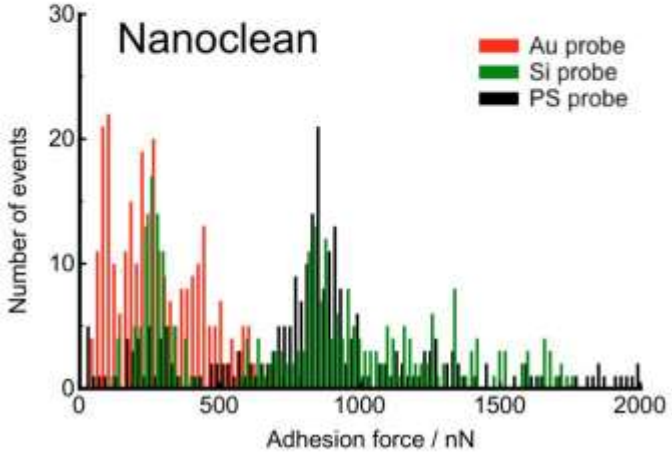
ADHESION FORCES

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 Nanocleen





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

CLEANING IN A VACUUM

- Does the Cleaning system detrimentally affect the performance of the vacuum system ?
- Does exposure to high vacuum alter the performance of the cleaning system?

TESTING COMPATIBILITY

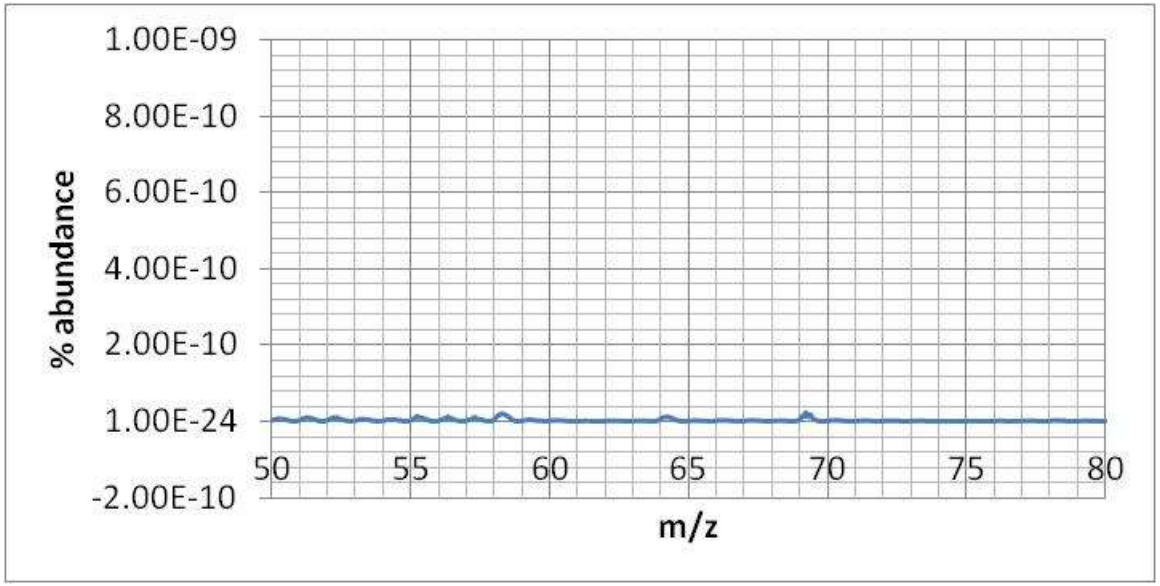
- Test for weight loss in all of the Cleaning system components
- Test for outgassing of the components and assess the composition by Residual Gas Analysis (RGA)
- Test the Particle Pick Up (PPU) performance of bothe the elastomer roller and the adhesive

Weight Loss

Roller Type	No.	Weight before Vacuum (g)	Weight after Vacuum (g)	Weight Difference (g)	% Weight Loss
Nanocleen	1	16.98	16.91	0.07	0.41
Nanocleen	2	17.16	17.1	0.06	0.35
Adhesive Sheet	1	4.3	4.3	0	0
Adhesive Sheet	2	4.2	4,.2	0	0

OUTGASSING

RGA Analysis of Nanocleen roller



PPU PERFORMANCE

Nanocleen Rollers		
	Vacuum Condition	**Particle Pickup (PPU) (g)**
Test 1	**Ambient**	**0.3**
Test 2	**Ambient**	**0.3**
Test 3	**1 Week in Vacuum $1X10^{-6}$ mbar**	**0.2**
Test 4	**1 Week in Vacuum $1X10^{-6}$ mbar**	**0.2**
Test 5	**1 Week in Vacuum $1X10^{-6}$ mbar**	**0.3**

AREAS OF APPLICATION

- After stripping of protective film to remove possibility of static induced recontamination
- Immediately prior to sputtering to remove any particles deposited from the walls of the chamber
- Before rewind to stop particles imprinting on the layer below or fracturing the film
- Cleaning the protective film at rewind prior to application to stop damage to the coating

CONCLUSIONS

- Weight loss before and after high vacuum storage of the Nanocleen rollers is about 0.4%. Measured weight loss is probably due to moisture/water outgassing.
- The Nanocleen rollers show no peaks in the RGA analysis, so there is no outgassing from this roller in vacuum.
- The particle pickup rate for the rollers and adhesive is not influenced by storing under high vacuum
- There are several areas within a vacuum system where Contact Cleaning could be implemented to reduce defects caused by particle contamination