

# Towards Zero Defects in Solution Coating

# Key Issues

- Identification of defect causes
  - Contamination
    - Particles
    - Organic and other contamination
  - Surface Quality

# Contamination

- **Dry unattached-Issue No 1**
  - Film Production Process
  - Environment
- **Contamination from static bars Issue No 2**
  - metal particles from emitter pins
- **Process Rollers-Issue No 3**
  - Microslip – build up of particles over time
- **Organics – Issue No 4**
  - Unreacted materials
  - Migrating additives
  - Low Molecular Weight Molecules (LMWM)
  - Bacteria and other biologicals

# Issue No 2

## Static Elimination Bars



- Standard bars problems
  - Emitter Pins
    - Pins slowly erode and shed particles
    - Removes static but adds contamination
  - Field Strength
    - Gaps between emitter pins results in varying field strength
    - This causes striping on coating
      - Particularly with thin, low viscosity coatings

# Issue No 2 -Tests

- No.1
  - Pin based bars
    - Bar placed in HEPA chamber
    - Measure particles  $\geq 10^{-9}\text{m}$
    - Particle count over time using Condensing Nucleus Counter
    - Measure regularly over 5 days
    - 4 bars
      - 2 x Standard pins Pulsed DC
      - 1 x Standard pins Pulsed AC
      - 1 x **Single Crystal emitter pins- 5635 (ITW)**
- No.2
  - Wire based bar 5710 (ITW)
    - 6 months in HEPA Chamber
    - Laser Particle Counter  $\geq 100^{-9}\text{m}$

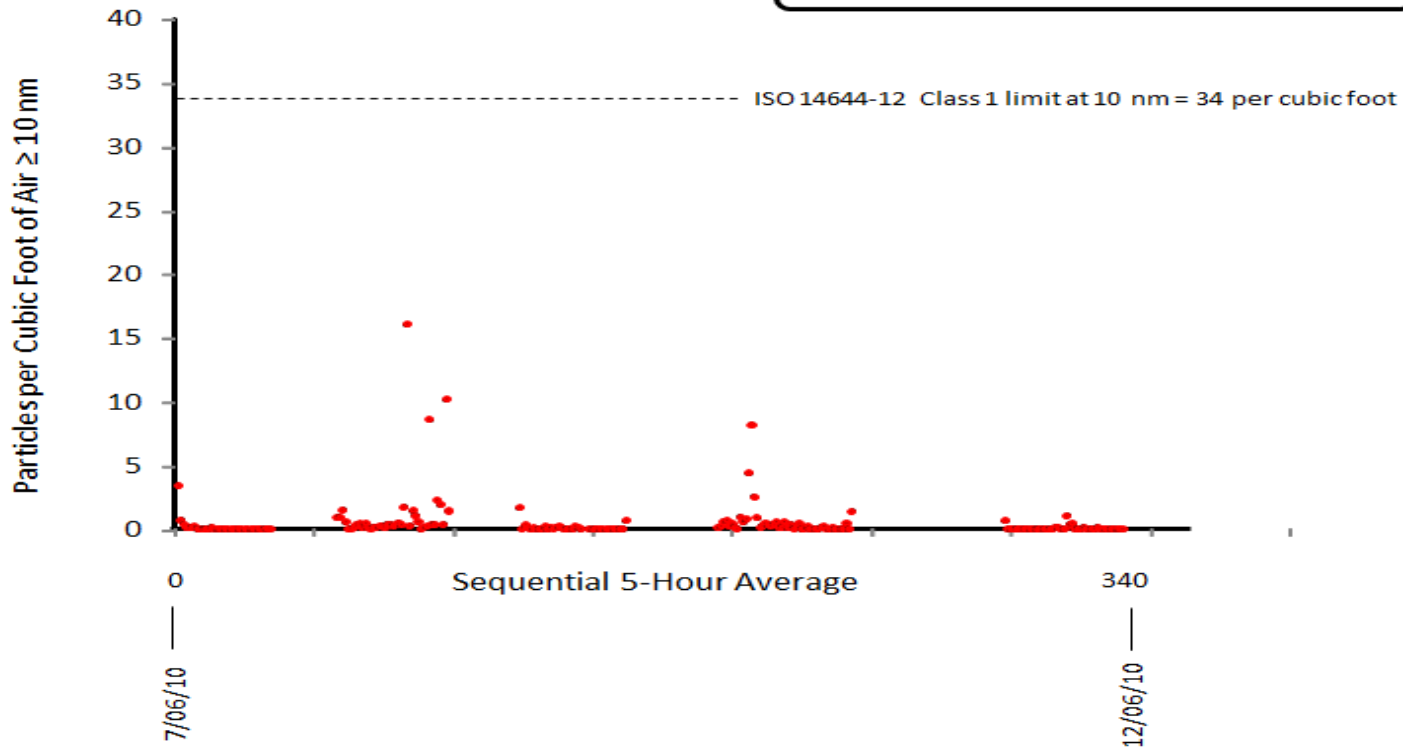
# Issue No.2

## Results – Emitter Pin

100K

Model 5635 Particle Test 07/06/10 through 12/06/10

Mean count at 10 nm = 0.52 per cubic foot

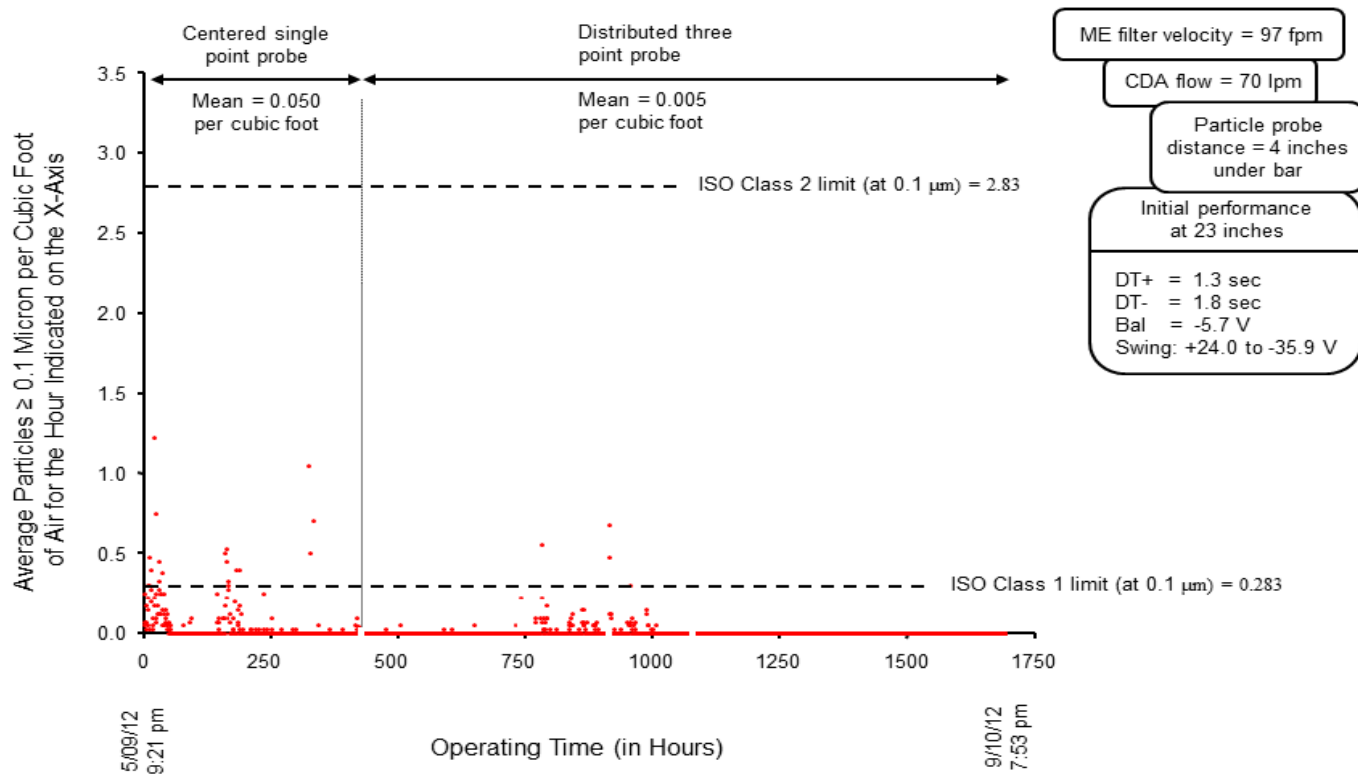


■ Pulsed DC Mean = 223.2    ▲ Pulsed DC Mean = 25.5  
● Pulsed AC Mean = 828.1    ● 5635 MP Mean = 0.52

# Issue No.2

## Results – Wire Bar

**Average Particles  $\geq 0.1$  Micron per Cubic Foot of Air Versus Operating Time (Hours) for the 1 Meter 5710 Bar After Clean-down, Showing ISO Class 1 Compliance**



# Issue No.2 Conclusions



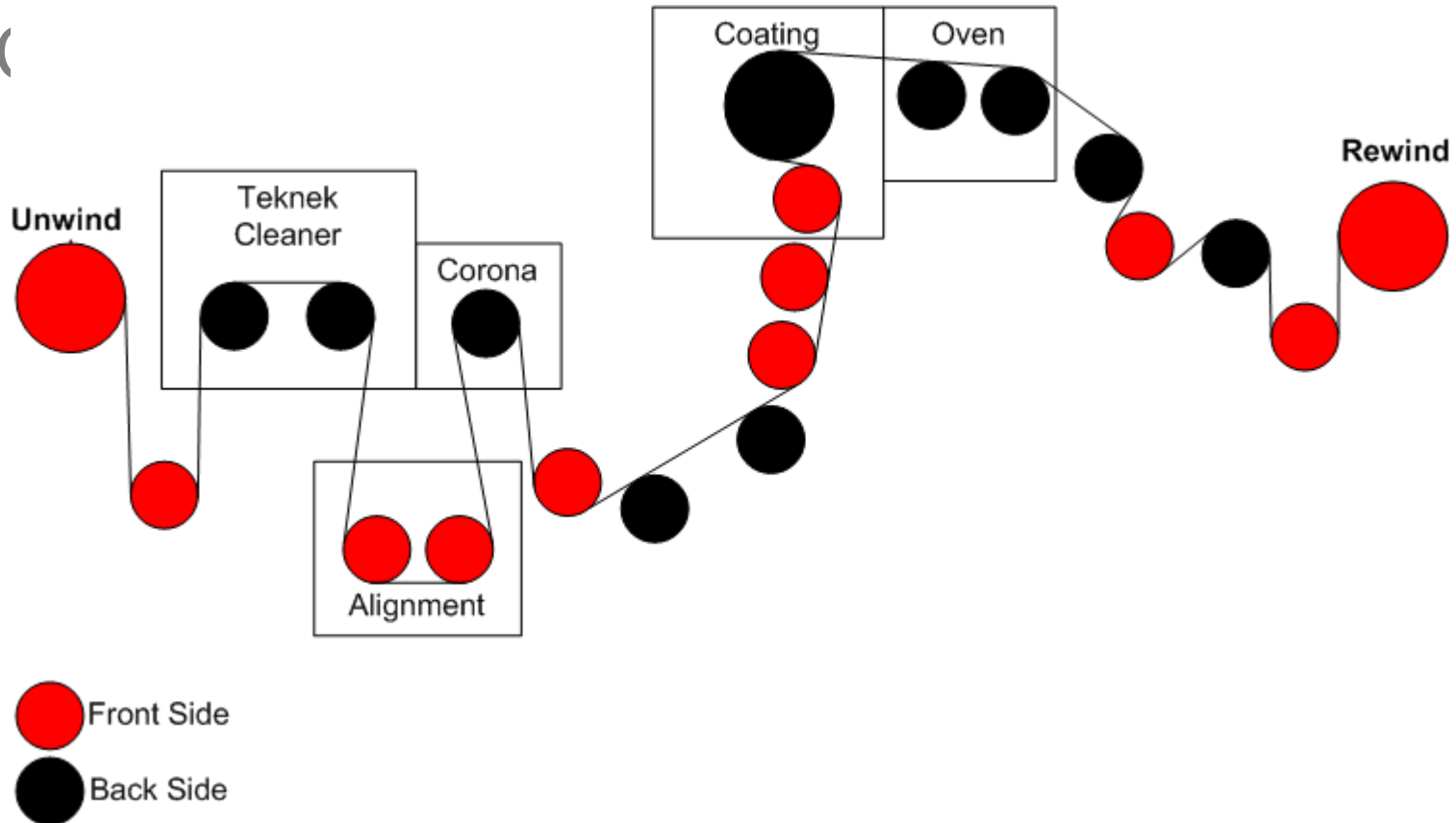
1. Conventional bars emit many particles
  - Single Crystal bars meet ISO 14644 Class 1 Extended – ultra clean
2. Conventional emitter pin designs produce non linear fields across the web
  - Wire bar meets ISO 14644 Class 1- ultra clean
  - Does not cause striping



# Issue No.3 Process Rollers

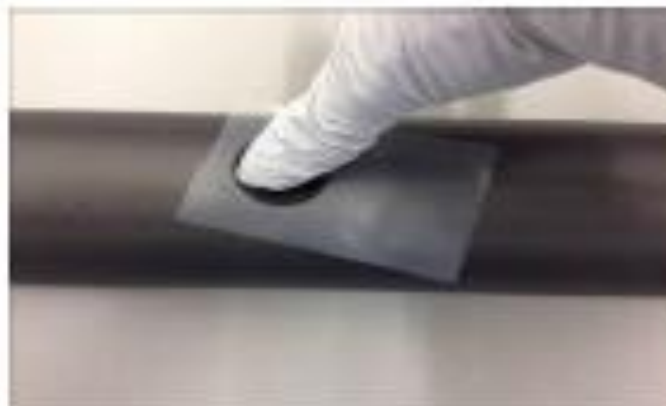
## What's the problem?

• (

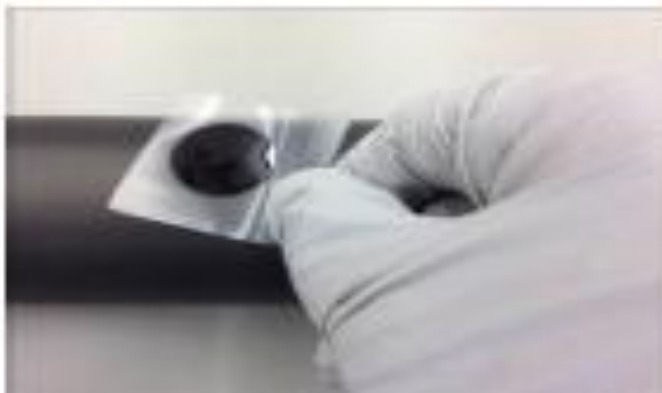


# Issue No 3 - Testing

- Test



- Procedure



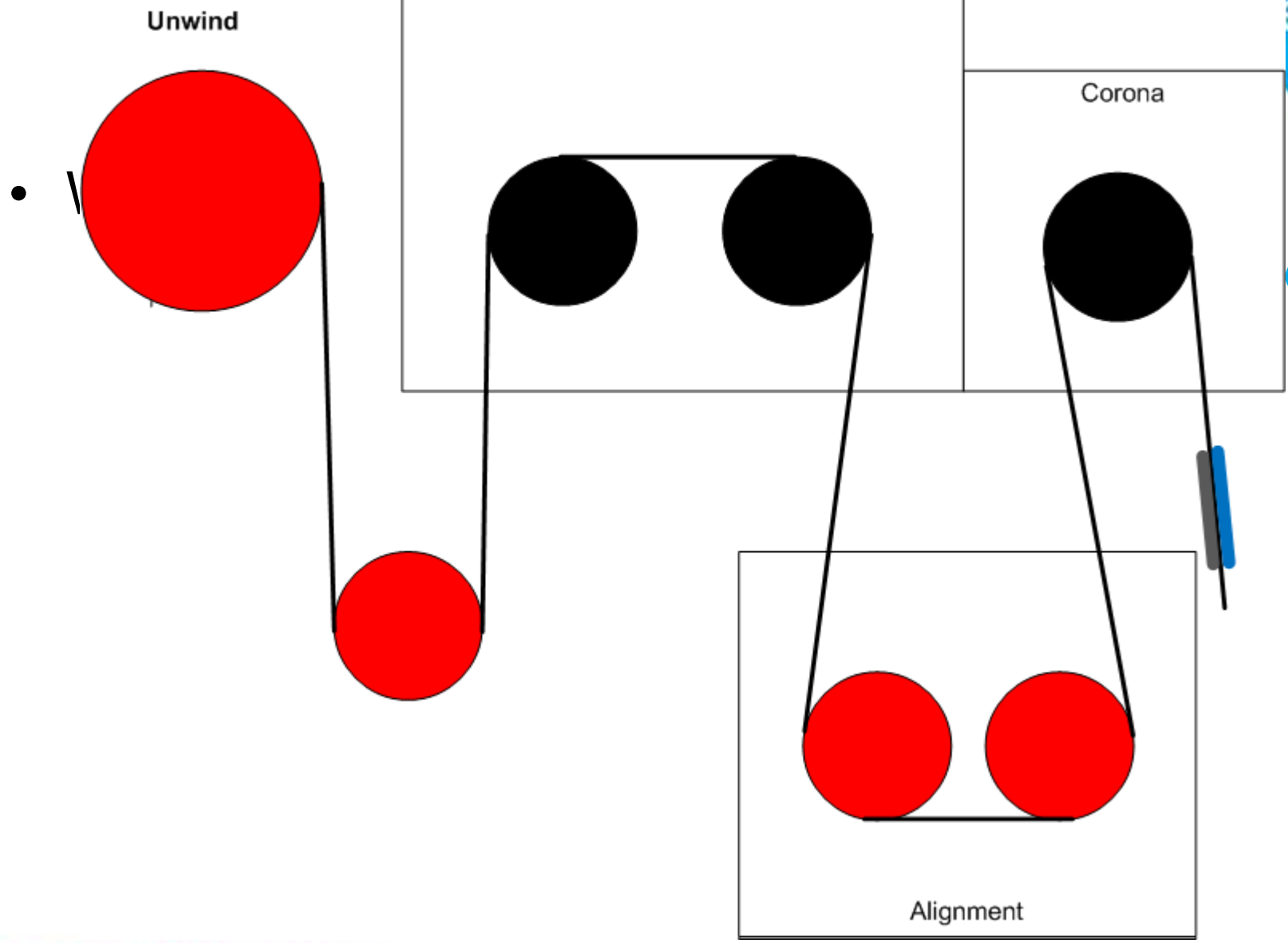
# Issue No.3

## Problem measured



date	FS roller particle level	processing adders
	#/m <sup>2</sup> *E6	#/m <sup>2</sup> pass
17-apr	0,77	231
17-apr	6,75	764
jun-20	7,40	875
22-mrt	10,10	1528





# Issue No 3 - Solved

- Use of Teknek CLC regularly reduces defects due to particles from Process Roller
- Simple, low cost and easy to use
- Available in units of 1sq metre. 1 metre wide.
- Can be reused after cleaning with Teknek cleaner – lasts around 1 month.

# Issue No.3

## Coating Line Cleaner - Results



- How effective is Teknek CLC?

Location	Uncleaned	After PRC
Cleaning sheet	6	
F/S after Unwind	324	7
F/S after Corona	70	7
F/S under Coater	362	3
Nip roller	94	2
F/S after Splice	64	4
F/S before Rewind	81	2

# Coating Line Cleaner in Action



An ITW Company



**WORLD LEADER IN CONTACT CLEANING**

[www.teknek.com](http://www.teknek.com)

# Issue No 4- Organics



- Organics
  - Variation in wettability- over time and within a roll
    - Increasing issue for thin coatings
    - Increasing issue for low viscosity coatings
  - Organics can cause point delamination – pin holes
  - Medical applications – sterile is best
    - Removing biologicals is an advantage



# Surface Quality

- Three areas
  - Cleaning , Organic – Issue No 3
    - Surface contamination can affect contact angle
  - Activation
    - Creates reactive groups. Prepares surface for functionalisation
  - Functionalisation
    - Adding gases and pre cursors to modify surface chemistry

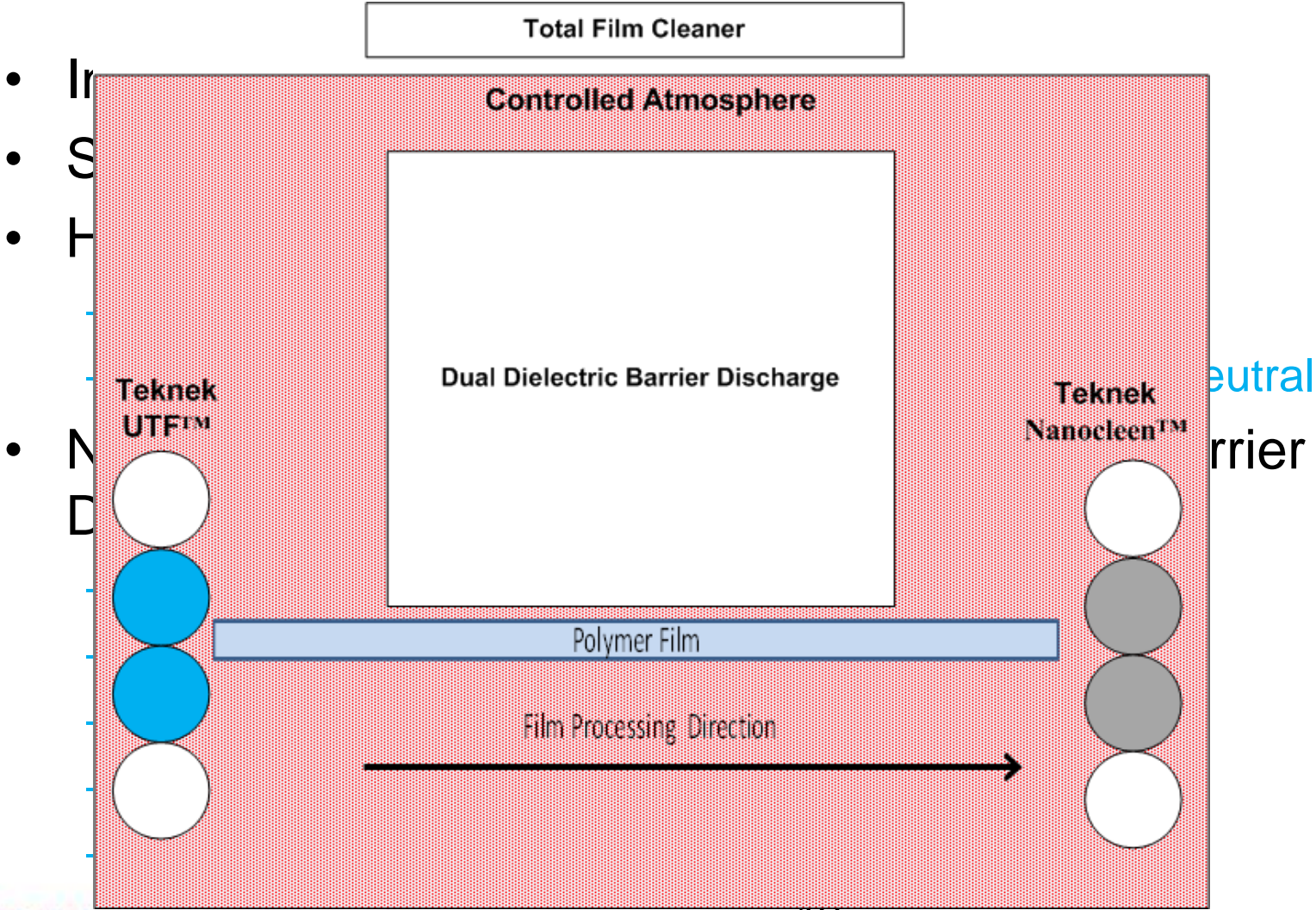
# Teknek Total Film Cleaning



- Removes Particles
- Removes Organics/Biologicals
- Provides Activation and Functionalisation

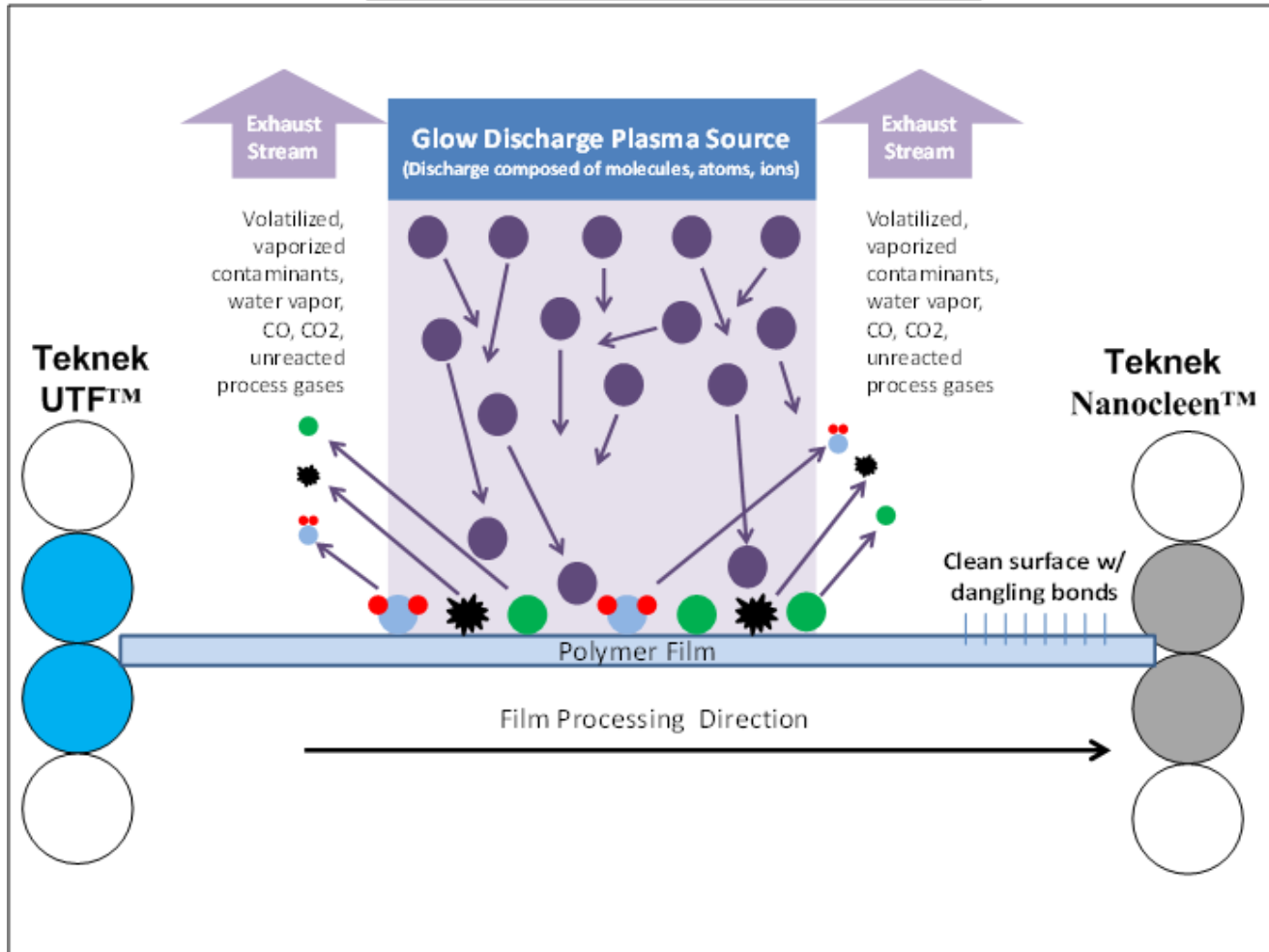
# Total Film Cleaning

## What is it?

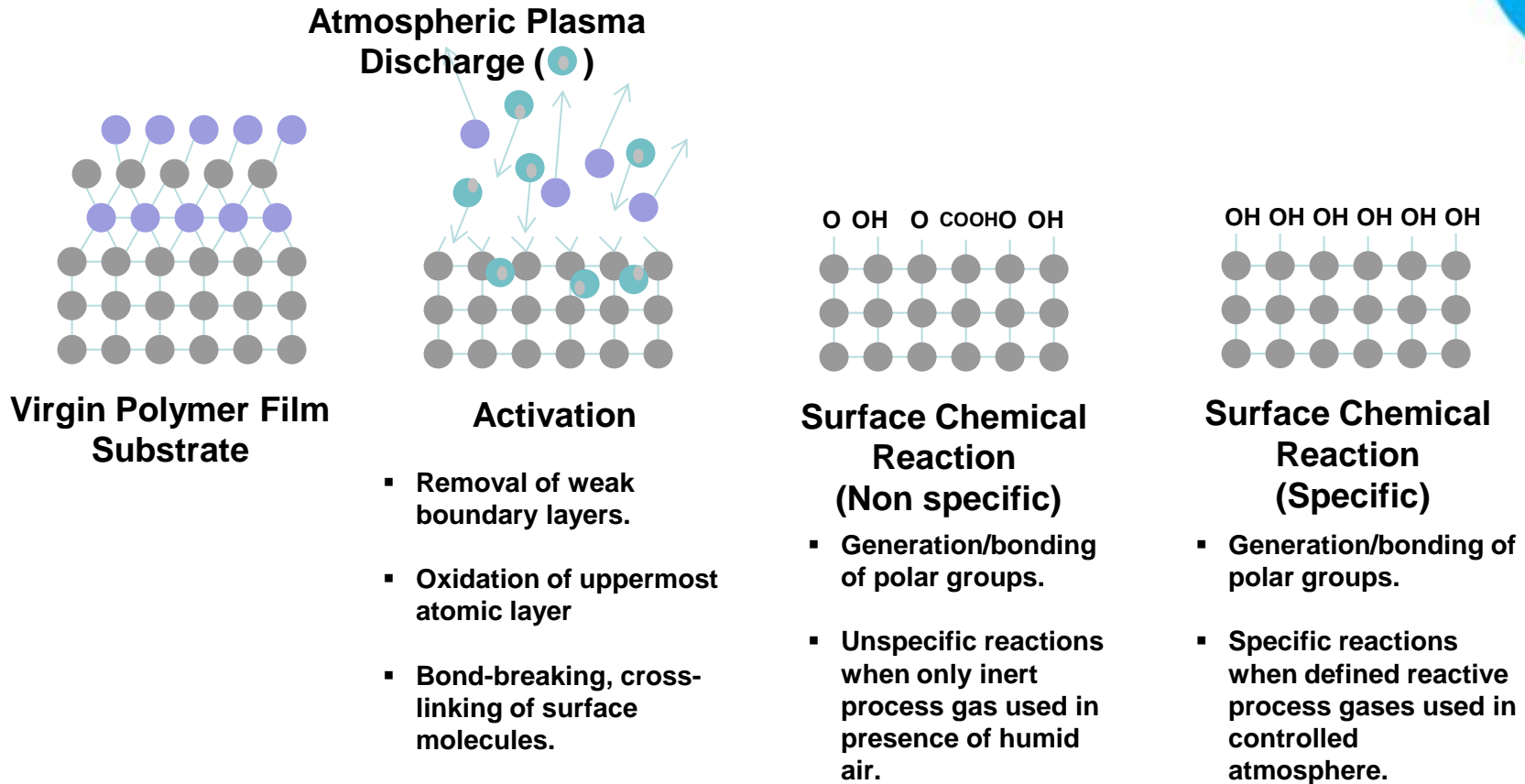


# Total Film Cleaning

## Total Film Cleaner



# DDBD Process



Conventional Atmospheric PD



Controlled Atmosphere PD



# TFC - Testing

- Tests performed by Eastman
  - XPS performed by Material Interface Inc.
- Substrate – Polyethylene
  - Contains fast migrating Oleamide, typical Film Additive
- Measured Surface Chemistry with XPS
  - Before and after TFC
- Measured Contact Angle across web width
- DDBD Parameters
  - 43watt minutes/m<sup>2</sup>
  - 100% Nitrogen

# TFC – Test Results



Sample	Spectrum	C	N	O	Na	S	Cl	K	Ca
<b>Bare PE</b>	1	89.8	0.9	6.3	1.4	0.1	0.3	0.6	0.2
<b>Treated PE</b>	2	83.8	2.2	13	0.1	-	-	-	-

Sample	Carbon as:				Nitrogen as:			Oxygen as:		Ionic Na	Sulfur as Sulfate	Cl as Chloride	Ionic K	Ca as Carbonate
	C-C,H	C-O	C=O	O-C=O	NO/ Nitride	Organic	Quarternary	=O	C-O					
Untreated PE	82.9	4.3	1.7	1	0.1	0.7	0.1	0	2.3	1.4	0.1	0.3	0.6	0.2
Treated PE	70.4	7.9	3.1	2.3		1.7	0.5	0.3	7.7	0.1	-	-	-	-

Analysis of Polyethylene Samples as Obtained by XPS. Data Normalized Atomic % of Elements Above Atomic Number 2 within 40Å of the Surface

- Change in Surface Chemistry indicates elimination of Oleamide

# TFC Test Results 2



Sample	Dynes/cm	Contact Angle - Cross (Transverse) Direction				
		Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
Untreated PE	32	97°	97°	97°	98°	98°
Treated PE	44	50°	50°	49°	50°	49°

- Homogenous change across full web width
- 50% reduction in Contact Angle 90 to 50



# TFC – Conclusions



- Teknek Cleaning with unique sealed DDBD provides
  - Cleaning of all contamination
  - Surface activation
  - Ability to add reactants to change Surface chemistry and polarity
- Operates at normal line speeds and web widths
- Single process takes standard film and converts it into higher value consistent quality film suitable for demanding applications.
- Incorporation of Next Generation Clean Static Elimination prevents re-contamination.