Static Control in Converting

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About Electrostatic Answers

Electrostatic Answers is an engineering consulting company for solving static problems and commercializing electrostatic technology. Dr. Kelly Robinson has over 27 years of problem solving experience with particular expertise in polymer film manufacturing, coating and converting. He lead an engineering team at Eastman Kodak that solved static problems in manufacturing operations and helped design new products to minimize static problems.

Electrostatic Answers is located near Rochester, New York serving clients all over the United States and Canada including several fortune 500 companies.

Dr. Robinson holds the Ph.D. degree in electrical engineering from Colorado State University. He has 13 US patents, has published many journal articles, and writes “Static Beat,” a monthly column for Paper, Film and Foil Converter (PFFC).

Please visit our website: www.ElectrostaticAnswers.com

Agenda

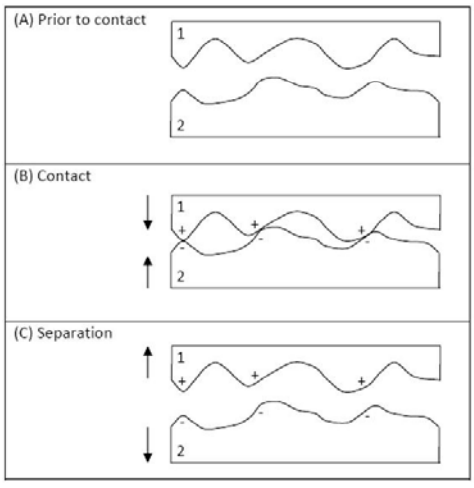
Static charge control is important because excessive static causes:

- waste,
- downtime, and
- headaches for your customers.

Today, we'll answer four key questions:

1. How is static generated?
2. How is static measured?
3. How is static controlled?
4. How is static specified?

Static Generation



- Electrostatic charge is separated whenever two chemically dissimilar surfaces touch and separate.
- Prior to contact in (A), both surfaces are neutral.
- Upon contact in (B), charge separation occurs at the points of contact. At a microscopic scale, only a small amount of surface area actually touches.
- Upon separation in (C), the surfaces are charged.

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TRIBOELECTRIC SERIES

Positive				Neutral			Negative				
inorganics & biological materials	exception	inorganics & biological materials	natural fibers	exceptions	natural resins	metals	exceptions	bio-polymers	hydrocarbons	fluorpolymers	exception
human skin glass human hair	nylon	cat fur silk alumina	paper cotton wood	steel PMMA poly(methyl methacrylate)	wax latex	copper brass gold platinum	synthetic rubber PET	acetate acrylic cellophane	polyurethane polyethylene polypropylene vinyl	PTFE (Teflon®)	silicone rubber

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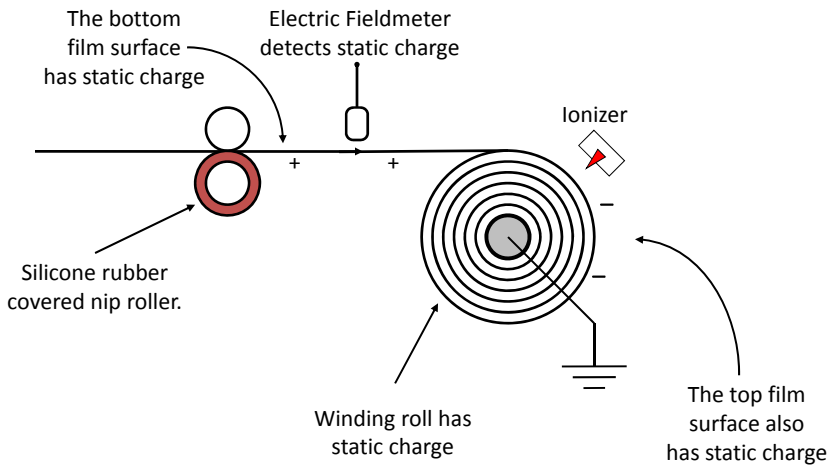
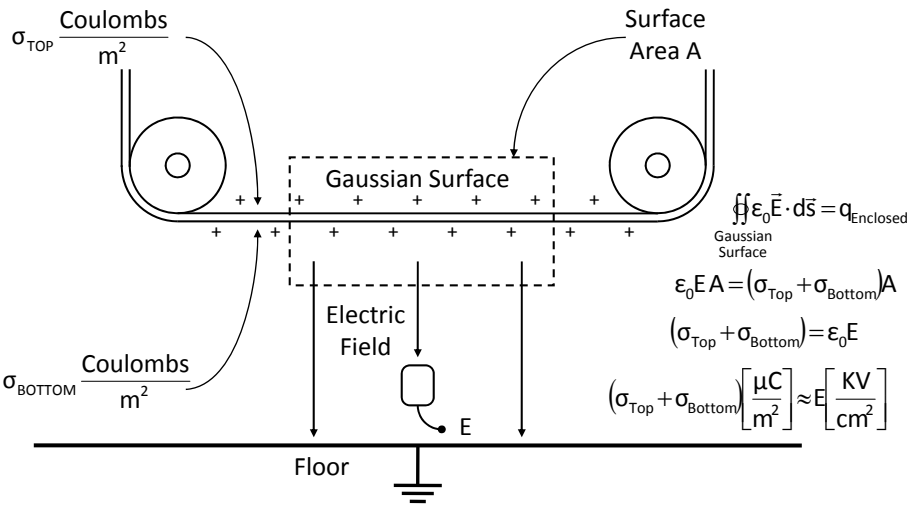
Static Charge on Incoming Material



Electrostatic Fieldmeter

SUMMARY: An electrostatic fieldmeter measures the average charge on both surfaces of the film over a large area; a circle with a dia. equal to the film width.

Electrostatic Fieldmeter Analysis



SUMMARY: An electrostatic fieldmeter measures the average charge on both surfaces of the film over a large area; a circle with a dia. equal to the film width.

Electrostatic Voltmeter

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SUMMARY: A non-contacting electrostatic voltmeter measures only the charge on the exposed surface of the film with high spatial resolution; ~1mm dia. circle.

Electrostatic Voltmeter Analysis

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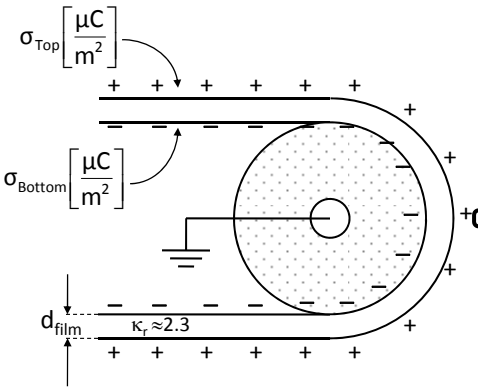


$$Q = CV \qquad \sigma_{Top} A = \left(\frac{\varepsilon_0 \kappa_r A}{d_{film}}\right) V_{Surface}$$

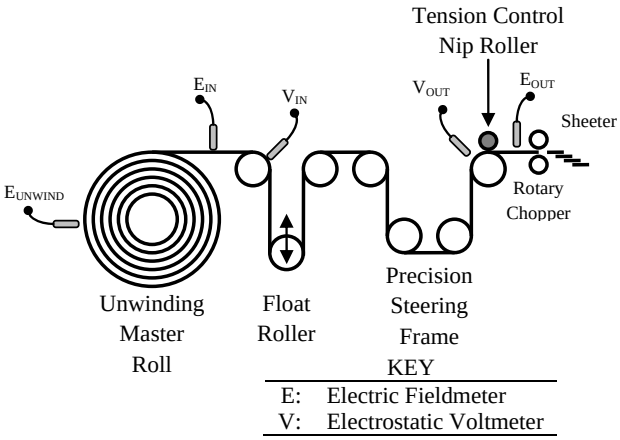
$$\sigma_{Top} = \left(\frac{\varepsilon_0 \kappa_r}{d_{film}}\right) V_{Surface}$$

$$\sigma_{Top}\left[\frac{\mu C}{m^2}\right] \approx \frac{20}{d_{film}[\mu m]} V_{Surface}[V]$$

SUMMARY: Non-contacting electrostatic voltmeters measure the charge on only one surface of the film with high spatial resolution; ~1mm dia. circle.

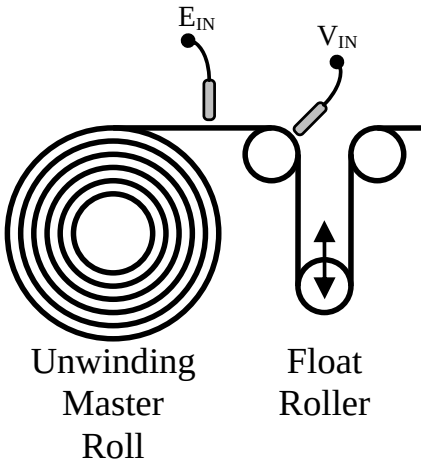
Baseline Measurements

Chopping and Sheeting Operation



We'll focus on incoming material and finished product.

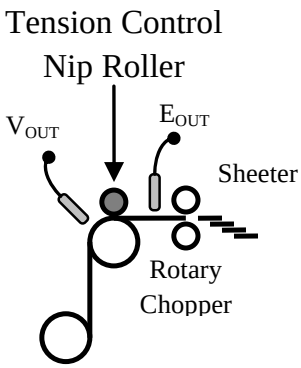
E_{IN} & V_{IN}



Measure the electric field E_{IN} on the film span between the unwinding stockroll and the first roller to verify that incoming material from your supplier has low static.

Measure the film surface potential V_{IN} on the first metal roller after the unwinder to verify that your incoming material has low static.

E_{OUT} & V_{OUT}



Measure the electric field E_{OUT} on the last film span where the film is continuous prior to chopping and sheeting to verify that your outgoing material to be delivered to your customer has low static.

Measure the film surface potential V_{OUT} on the last metal roller where the film is continuous prior to chopping and sheeting to verify that your outgoing material has low static.

STATIC CONTROL COUNTER MEASURES

	Action	Description
1.	Machine Maintenance	Clean roller surfaces to reduce tribocharging. Clean or replace belts that touch the film to reduce tribocharging and restore traction. Replace bearings to prevent slipping
2	Process Adjustments	Increase relative humidity (RH) to reduce levels of static. Lower film tension to reduce tribocharging. Lower nip roller engagement pressures to reduce tribocharging.
3	Reduce Static on Incoming Material	Work with your supplier to reduce static on incoming material. Agree on a static specification on incoming material with your supplier. Monitor static on incoming material to prevent static problems.
4	Install Static Dissipaters	Use baseline and diagnostic static measurements to identify sources of charging. Locate static dissipaters facing the side of the film with the charge to be neutralized

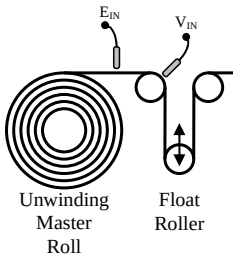
STATIC DISSIPATON DEVICES

Description	Type	Cost	Performance / Comments
Tinsel	Passive	Low	Sufficient to suppress sparks and lower dust attraction. No external power is needed. Ineffective at low levels of charge. Performance can degrade quickly with time as tinsel strands become matted
Static String™, Static Elastic™ Ion360™ Rods	Passive	Low	Sufficient to suppress sparks and lower dust attraction. No external power is needed. Ineffective at low levels of charge. More robust that tinsel.
Ionizing Air Blower	Active	Medium	Intended for applications where parts have a long residence time in the airflow (e.g. electronic work stations). Can dissipate low levels of charge. Devices can have a long life with periodic maintenance.

STATIC DISSIPATION DEVICES

Description	Type	Cost	Performance / Comments
Shockless Pin Array Ionizer	Active	Medium	Intended for use in solvent rated areas or where there is a possibility that a person could touch an ionizing pin. Relatively high ion output. Devices can have a long life (years) with periodic maintenance.
High Output Pin Array Ionizer	Active	Medium	Intended for high speed (short residence time) applications. Depending on the geometry, ionizers can be located some distance (several feet) from charge to be dissipated. Devices can have a long life (years) with periodic maintenance.
Radioactive Source	Active	High	Alpha and Beta emitters are commercially available. No external power is needed. Intended for applications where external power and/or light is not permitted. Regulatory compliance and regular inspections are burdensome.
Corona Wire Ionizer	Active	High	Highest performance in terms of ion output and uniformity. Used extensively in photocopiers. Regular maintenance and cleaning are essential to maintain performance.

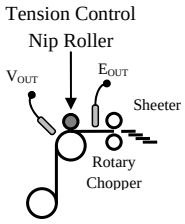
Sample Static Specification



Incoming Material:

$$E_{IN} < \pm 4 \frac{KV}{cm} = \pm 10 \frac{KV}{in}$$

$$V_{IN} < \pm 30 \text{ Volts}$$



Outgoing Material:

$$E_{OUT} < \pm 4 \frac{KV}{cm} = \pm 10 \frac{KV}{in}$$

$$V_{OUT} < \pm 30 \text{ Volts}$$

Summary

The **GOAL** is to produce electrically neutral film.

Electrostatic fieldmeters measure the average charge on both film surfaces over a large area (circle with a dia. of the film width.

Non-contacting electrostatic voltmeters measure the charge on only the exposed film surface with relatively high spatial resolution (~1 mm dia. circle).

Identify sources of film charging by taking baseline measurements.

Always position static dissipaters on the side of the film with the charge to be neutralized.

Work with your vendors and customers to agree on static specifications to prevent static problems in converting.

QUESTIONS?

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APPENDIX

Following slides held in reserve
to help answer questions

1. E_{UNWIND}

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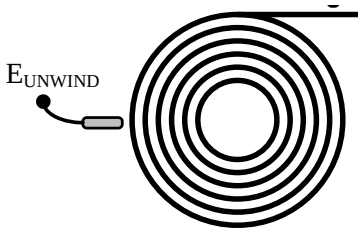

Unwinding Master Roll

Unwinding film often generates high levels of static where the outer lap is peeled from the stockroll. Find this static source by measuring the electric field E_{UNWIND} at the surface of the unwinding stockroll.