electro-tech systems, inc.
3101 Mt. Carmel Avenue, Glenside, PA 19038 • Tel: (215) 887-2196 • Fax: (215) 887-0131

MATERIAL TEST REPORT

R&R LOTION, INC.

STATIC DECAY, SURFACE RESISTANCE AND SURFACE RESISTIVITY TESTING OF TOPICAL ANTISTAT SAMPLE PT#1 CAS-32

FEBRUARY 16, 2001

MATERIAL EVALUATION REPORT
R&R Lotion, Inc.
Testing of Topical Antistat
PT#1 CAS-32
February 16, 2001

GENERAL

Electrostatic characterization tests were performed by ETS Testing Laboratories on samples submitted by R&R Lotion under Purchase Order Number 240045. The samples were tested for:

- **STATIC DECAY**
- **SURFACE RESISTIVITY**
- **SURFACE RESISTANCE**

Testing was performed at two relative humidity levels. Six (6) samples were tested at each conditioning level.

TEST CONDITIONS

For testing purposes the topical antistat was sprayed onto 4" x 6" samples of insulative film and allowed to air dry before being placed into the conditioning chamber. Prior to testing, the first group of samples were preconditioned for a period of 48 hours at a relative humidity of 12.0% and a temperature of 72°F. A second group of samples were preconditioned in a separate environment for a period of 48 hours at a relative humidity of 40.3% and a temperature of 72°F. Both groups were tested under these conditions on February 16, 2001.

TEST APPARATUS

HUMIDITY CONTROL

An ETS Model 506A/514 Humidity Control Chamber is used to provide the controlled environment to condition and test the samples at the specified relative humidity. The system is capable of controlling the humidity to within 0.5% of the desired level with an accuracy of ±2% R.H. and is calibrated to standards traceable to N.I.S.T.

STATIC DECAY

An ETS Model 406C Static Decay Meter is used to perform static decay measurements. An ETS STM-1 System Test Module is used to verify the calibration of the Static Decay Meter.

SURFACE RESISTIVITY/SURFACE RESISTANCE

Surface resistivity and surface resistance measurements of planer material are performed using a Dr. Thiedig Milli-TO-2 Wide Range Resistance Meter in conjunction with an ETS Model 803B Surface/Volume Resistivity Probe. An ETS Model 809B Calibration Check Fixture is used to verify the calibration of the resistance test set-up.

TEST METHODS

The following test methods and specifications were used in the evaluation of the test material:

STATIC DECAY

The static decay test is based on the method described in Federal Test Method Standard (FTM) 101C, Method 4046 "Electrostatic Properties of Materials". This test method requires that a 3 x 5-inch test specimen be placed between a pair of electrodes electrically connected together and be conductively charged to both plus and minus 5kV. After the

sample has accepted the applied charge, the charging voltage is removed, the electrodes are grounded and the time for the charge to bleed down to a specified cutoff level measured. This test can also be modified to evaluate different sizes and configurations. Most military and electronic industry specifications require decay time to be measured to the 1% (50 volt) cutoff level. (This was previously designated as 0%). Applications referenced to NFPA (National Fire Protection Association) specifications require the decay time to be measured to the 10% (500 volt) cutoff level.

CALIBRATION CHECK

Prior to the static decay evaluation a performance system check is made using the ETS Model STM-1 System Test Module. The STM-1 is placed in the Faraday Test Cage in lieu of a test specimen. It produces a known decay time when plus and minus 5kV is applied. This test checks both the accuracy of the decay time measurement and the balance in decay times between positive and negative charging voltage polarities.

INITIAL/ACCEPTED CHARGE INDICATION

Material that is static dissipative or conductive will have no initial measurable static charge on the surface and will be able to conduct the total 5kV charge across the surface when applied. A sample that has a measurable initial charge prior to applying the 5kV indicates that the sample is either insulative or contains both dissipative and insulative characteristics across the surface being tested. The magnitude of the initial charge is listed in the IC Volts column of the data sheet. Generally, a material that has both an initial charge and accepts the applied 5kV will not have a measurable decay time if the cutoff point is below the initial charge level.

Material with an initial charge and/or very long or no charge/decay characteristics can be evaluated by noting the amount of charge conducted across the surface of the test material after applying 5kV for one (1) minute. The more charge accepted after one minute the more dissipative the material. This value is listed in the AC Volts column of the data sheet. No readings are recorded under "DECAY TIME."

SURFACE RESISTIVITYSURFACE RESISTANCE

Surface resistivity per ASTM-D 257 has generally been the property used to describe the conductive, dissipative or insulative range of static control material. The ETS Series 800 probes conform to the concentric ring design specified. The ratio between the inner and outer electrodes results in a surface resistivity equal to 10X the measured resistance. It should be noted that surface resistivity is expressed in ohms per square, without regard to the size of the square.

Surface resistance per ESD S11.11 is the latest standard to be adopted to evaluate static dissipative material. This resistance is equal to the actual resistance measured with the Model 803B Probe. A test voltage of 10 volts is specified for resistances between 10^4 and 10^6 ohms. A test voltage of 100 volts is required for resistances between 10^6 and 10^{11} ohms. Surface resistance is expressed in ohms. Resistance measurements below or above these values may require different test voltages. Conductive materials (those materials with surface resistances below 10^4 ohms) are measured using either a current source or voltages equal to or less than 10 volts.

TEST RESULTS

The actual data taken is contained in the enclosed data sheets, along with group averages, minimum and maximum readings, and where applicable, standard deviation and process spread.

STATIC DECAY

12% RH - The samples were charged to ±5kV and the time to dissipate 99% of the charge (1% cutoff) when grounded was measured. The static decay time for the samples were as follows:

GROUP	**MIN**	**MAX**	**AVERAGE** (Time in Seconds)
A	0.03	0.15	0.07

No initial charges were recorded and the full 5kV was accepted.

40% RH - The samples were charged to ±5kV and the time to dissipate 99% of the charge (1% cutoff) and 90% (10% cutoff) when grounded was measured. The static decay time for the samples were as follows:

GROUP	**MIN**	**MAX**	**AVERAGE** (Time in Seconds)
A (1% Cutoff)	0.01	0.02	0.01
a (10% Cutoff)	0.01	0.01	0.01

No initial charges were recorded and the full 5kV was accepted.

SURFACE RESISTIVITY

12% - The surface resistivity measurement for the sample group was as follows:

GROUP	**MIN**	**MAX**	**AVERAGE** (Ohms/Square)
A	4.22×10^9 Ω/sq.	7.00×10^9 Ω/sq.	5.51×10^9 Ω/sq.

40% - The surface resistivity measurement for the sample group was as follows:

GROUP	**MIN**	**MAX**	**AVERAGE** (Ohms/Square)
A	4.50×10^8 Ω/sq.	1.18×10^9 Ω/sq.	7.02×10^8 Ω/sq.

Testing was performed using a test voltage of 100 volts.

SURFACE RESISTANCE

12% - The surface resistance measurement for the sample group was as follows:

GROUP	**MIN**	**MAX**	**AVERAGE** (Ohms)
A	4.22×10^8 Ω	7.00×10^8 Ω	5.51×10^8 Ω

40% - The surface resistance measurement for the sample group was as follows:

GROUP	**MIN**	**MAX**	**AVERAGE** (Ohms)
A	4.50×10^7 Ω	1.18×10^8 Ω	7.02×10^7 Ω

Testing was performed using a test voltage of 100 volts.

CONCLUSIONS

STATIC DECAY

12% - According to industry specifications such as EIA-541 and Mil-B-81705-D (which both utilize FTM 101C Method 4046), a material which has been preconditioned at 12% R.H. for a minimum of 48 hours should have a static decay time of less than 2.0 seconds when measured to a 1% (50 volt) cutoff level for it to be considered acceptable for use in static safe environments.

With an average static decay time of 0.07 seconds, the topical antistat meets the requirements of the specification.

40% - NFPA 99 is commonly specified for hospitals, cleanrooms and hazardous locations and is also used as a guideline for consumer products. This specification, which also references Method 4046, requires conditioning at 50% R.H. Acceptable materials should have a static decay time of less than 0.50 seconds when measured to the 10% (500 volt) cutoff level. Testing was performed at 40% R.H as requested.

With an average static decay time of less than 0.01 seconds at both the 10% (500 volt) and 1% (50 volt) cutoff levels, the topical antistat samples met the requirement of this specification.

RESISTIVITY AND RESISTANCE

Resistance measurements are used in the static control industry to help categorize materials. Although resistance and resistivity measurements alone cannot tell everything about a material's electrostatic performance, it is a good indicator and can help to establish a baseline, indicate differences between additives or additive levels, show differences within a sample group and characterize the effects of relative humidity on a material's performance.

	SURFACE RESISTIVITY	**SURFACE RESISTANCE**
Conductive	$<1 \times 10^5$ ohms/sq.	$<1 \times 10^4$ ohms
Dissipative	1×10^5 to 1×10^{12} ohms/sq.	1×10^4 to 1×10^{11} ohms
Insulative	$>1 \times 10^{12}$ ohms/sq.	$>1 \times 10^{11}$ ohms

SURFACE RESISTIVITY

According to specifications such as EIA-541 and Mil-B-81705-D, a material with surface resistivity measurements less than 1×10^5 ohms/sq. is considered conductive, between 1×10^5 and 1×10^{12} ohms/sq. is considered dissipative and readings above 1×10^{12} ohms/sq. classify the material as insulative.

With an average surface resistivity measurement of 5.51×10^9 ohms/sq. at 12% R.H. and 7.02×10^8 ohms/sq. at 40% R.H., the samples met the requirements for a static dissipative material.

SURFACE RESISTANCE

ESD S11.11 is the latest method used to classify static dissipative planer material using surface resistance. This test method will be incorporated into the various specifications as published specifications are updated. The ESD industry generally uses the following guidelines. Material having a surface resistance measurement of less than 1×10^4 ohms is considered conductive, between 1×10^4 and 1×10^{11} ohms is considered dissipative and readings greater than 1×10^{11} ohms would classify the material as insulative. Depending on the specification referenced and the composition of the material, either surface resistivity or surface resistance (or both) may be applicable.

With an average surface resistance measurement of 5.51×10^8 ohms at 12% R.H. and 7.02×10^7 ohms at 40% R.H., the samples meet the requirements for a static dissipative material.

Static decay, surface resistance and surface resistivity testing indicate that the topical antistat is acceptable for use in ESD safe applications at both high and low relative humidity levels.

ANALYZING YOUR DATA SHEETS

As part of our continuing effort to meet the demands of our customers, ETS has expanded the capabilities of our testing laboratory to provide a more detailed format which allows in-depth analysis of the data obtained during testing. This information allows you to analyze the results of individual specimens and groups. Please note that only those parameters pertinent to the specific test are listed with each group of data. Each separate test that is performed will include a header, test result, data analysis of individual sample and data analysis of groups (when applicable). Please refer to your test report for additional information.

HEADER

This section of your data report lists all the applicable parameters such as the Purchase Order Number, sample description, test conditions and the equipment used to perform the test.

TEST RESULTS

The test results section lists the individual measurements taken for each sample and all pertinent measurement information.

DATA ANALYSIS OF INDIVIDUAL SAMPLES

The readings of each individual sample are subjected to analysis such as average, standard deviation, range, minimum & maximum.

DATA ANALYSIS OF GROUPS

When applicable, ETS will perform group calculations on the topics covered above. This allows the customer to view the overall performance of a sample group. This section is especially useful in providing information on specification compliance, group uniformity, new vs. aged samples, formed vs. unformed materials, etc.

AVERAGE

The average represents the mean value of all readings. The readings are summed and divided by the total number of data points.

STANDARD DEVIATION

The standard deviation represents the reliability of the data obtained. The higher the standard deviation, the more likely it is that readings far from the average will be obtained in subsequent tests. The standard deviation is calculated by taking the square root of the sum of the squares of the numeric difference between the reading and the average for each sample, divided by the number of readings considered.

MINIMUM	MAXIMUM
The lowest reading obtained in a sample group.	The highest reading obtained

R&R Lotions

P.O.# 240045-2 Static Decay Testing of Antistatic Spray

Date in Chamber	: 02/14/01	Date Tested	: 02/16/01
Time in Chamber	: 14:00	Time Tested	: 14:00
Ambient Humidity	: 28.0% R.H.	Test Humidity	: 12.0% R.H.
Ambient Temperature	: 75 F	Test Temperature	: 72 F
Hours Conditioned	: 48 hours		
Electrode Type	: Clamp Electrodes		
Meter	: ETS Model 406 Static Decay Meter		
Chamber	: ETS Model 506 Humidity Control Chamber		
Controller	: ETS Model 514 Automatic Humidity Controller		

Test Results

SAMPLE	I.C. Volts	A.C. Volts	C/O	DECAY @ +5kV Seconds			DECAY @ -5kV Seconds			R.C.
Calibration	0	5000	1%	0.60	0.60	0.59	0.61	0.60	0.61	
Group A:										
#1	0	5000	1%	0.07	0.07	0.08	0.08	0.07	0.08	
#2	0	5000	1%	0.03	0.04	0.03	0.04	0.04	0.04	
#3	0	5000	1%	0.04	0.04	0.04	0.05	0.05	0.04	
#4	0	5000	1%	0.04	0.04	0.05	0.05	0.05	0.05	
#5	0	5000	1%	0.15	0.14	0.14	0.14	0.15	0.15	
#6	0	5000	1%	0.04	0.04	0.04	0.05	0.04	0.05	
				Group Min:		0.03	Group Max:		0.15	

Data Analysis of Individual Samples

SAMPLE	AVERAGE +5kV	AVERAGE -5kV	STANDARD DEVIATION +5kV	STANDARD DEVIATION -5kV	PROCESS SPREAD +5kV		PROCESS SPREAD -5kV	
Group A:								
#1	0.073	0.077	0.005	0.005	0.06	0.09	0.06	0.09
#2	0.033	0.040	0.005	0.000	0.02	0.05	0.04	0.04
#3	0.040	0.047	0.000	0.005	0.04	0.04	0.03	0.06
#4	0.043	0.050	0.005	0.000	0.03	0.06	0.05	0.05
#5	0.143	0.147	0.005	0.005	0.13	0.16	0.13	0.16
#6	0.040	0.047	0.000	0.005	0.04	0.04	0.03	0.06

Data Analysis of Groups

Group	Average +5kV	Average -5kV	Standard Deviation +5kV	Standard Deviation -5kV	Range (avg) +5kV		Range (avg) -5kV	
A	0.062	0.068	0.039	0.037	0.00	0.18	0.00	0.18
	0.065		0.038		0.00		0.18	

R&R Lotions

P.O.# 240045-2 Surface Resistance/Resistivity Testing of Antistatic Spray

Date in Chamber	: 02/14/01	Date Tested	: 02/16/01
Time in Chamber	: 14:00	Time Tested	: 14:00
Ambient Humidity	: 28.0% R.H.	Test Humidity	: 12.0% R.H.
Ambient Temperature	: 75 F	Test Temperature	: 72 F
Hours Conditioned	: 48 hours		
Meter Type	: Dr. Theidig Milli TO-2		
Probe Type	: ETS Model 803B		
Calibration Fixture	: ETS Model 809B (5.00		x 10^5 ohms)
Chamber	: ETS Model 506 Humidity Control Chamber		
Controller	: ETS Model 514 Automatic Humidity Controller		

Test Results

Sample	Ve	Surface Resistance Ohms	Surface Resistivity Ohms/Square
Calibration	10	5.05 x 10^5	
Group A:			
#1	100	5.53 x 10^8	5.53 x 10^9
#2	100	5.17 x 10^8	5.17 x 10^9
#3	100	7.00 x 10^8	7.00 x 10^9
#4	100	6.18 x 10^8	6.18 x 10^9
#5	100	4.95 x 10^8	4.95 x 10^9
#6	100	4.22 x 10^8	4.22 x 10^9

Data Analysis

	Surface Resistance			Surface Resistivity		
	Min	Avg	Max	Min	Avg	Max
A	4.22 x 10^8	5.51 x 10^8	7.00 x 10^8	4.22 x 10^9	5.51 x 10^9	7.00 x 10^9

R&R Lotions

P.O.# 240045 Static Decay Testing of Antistatic Spray

Date in Chamber	: 02/14/01	Date Tested	: 02/16/01
Time in Chamber	: 14:00	Time Tested	: 14:30
Ambient Humidity	: 26.0% R.H.	Test Humidity	: 40.3% R.H.
Ambient Temperature	: 74 F	Test Temperature	: 72 F
Hours Conditioned	: 48 hours		
Electrode Type	: Clamp Electrodes		
Meter	: ETS Model 406 Static Decay Meter		
Chamber	: ETS Model 506 Humidity Control Chamber		
Controller	: ETS Model 514 Automatic Humidity Controller		

Test Results

SAMPLE	I.C. Volts	A.C. Volts	C/O	DECAY @ +5kV Seconds			DECAY @ -5kV Seconds			R.C.
Calibration	0	5000	1%	0.28	0.28	0.28	0.30	0.30	0.30	
Group A:										
#1	0	5000	1%	0.01	0.01	0.01	0.02	0.02	0.02	
#2	0	5000	1%	0.01	0.01	0.01	0.01	0.02	0.01	
#3	0	5000	1%	0.01	0.01	0.01	0.01	0.01	0.02	
#4	0	5000	1%	0.01	0.02	0.01	0.02	0.01	0.02	
#5	0	5000	1%	0.01	0.01	0.01	0.01	0.01	0.01	
#6	0	5000	1%	0.01	0.01	0.01	0.02	0.02	0.02	
				Group Min:		0.01	Group Max:		0.02	
Group a:										
#1	0	5000	10%	0.01	0.01	0.01	0.01	0.01	0.01	
#3	0	5000	10%	0.00	0.01	0.01	0.01	0.01	0.01	
#4	0	5000	10%	0.01	0.01	0.01	0.01	0.01	0.01	
#5	0	5000	10%	0.01	0.01	0.01	0.01	0.01	0.01	
#6	0	5000	10%	0.01	0.00	0.01	0.01	0.01	0.01	
				Group Min:		0.01	Group Max:		0.01	

Data Analysis of Individual Samples

SAMPLE	AVERAGE +5kV	AVERAGE -5kV	STANDARD DEVIATION +5kV	STANDARD DEVIATION -5kV	PROCESS SPREAD +5kV		PROCESS SPREAD -5kV	
Group A:								
#1	0.010	0.020	0.000	0.000	0.01	0.01	0.02	0.02
#2	0.010	0.013	0.000	0.005	0.01	0.01	0.00	0.03
#3	0.010	0.013	0.000	0.005	0.01	0.01	0.00	0.03
#4	0.013	0.017	0.005	0.005	0.00	0.03	0.00	0.03
#5	0.010	0.010	0.000	0.000	0.01	0.01	0.01	0.01
#6	0.010	0.020	0.000	0.000	0.01	0.01	0.02	0.02

R&R Lotions

P.O.# 240045 Surface Resistance/Resistivity Testing of Antistatic Spray

Date in Chamber	: 02/14/01	Date Tested	: 02/16/01
Time in Chamber	: 14:00	Time Tested	: 14:30
Ambient Humidity	: 26.0% R.H.	Test Humidity	: 40.3% R.H.
Ambient Temperature	: 74 F	Test Temperature	: 72 F
Hours Conditioned	: 48 hours		
Meter Type	: Dr. Theidig Milli TO-2		
Probe Type	: ETS Model 803B		
Calibration Fixture	: ETS Model 809B (5.00		x 10^5 ohms)
Chamber	: ETS Model 506 Humidity Control Chamber		
Controller	: ETS Model 514 Automatic Humidity Controller		

Test Results

Sample	Ve	Surface Resistance Ohms	Surface Resistivity Ohms/Square
Calibration	10	5.05 x 10^5	
Group A:			
#1	100	1.18 x 10^8	1.18 x 10^9
#2	100	8.20 x 10^7	8.20 x 10^8
#3	100	4.70 x 10^7	4.70 x 10^8
#4	100	4.50 x 10^7	4.50 x 10^8
#5	100	6.10 x 10^7	6.10 x 10^8
#6	100	6.80 x 10^7	6.80 x 10^8

Data Analysis

	Surface Resistance			Surface Resistivity		
	Min	Avg	Max	Min	Avg	Max
A	4.50 x 10^7	7.02 x 10^7	1.18 x 10^8	4.50 x 10^8	7.02 x 10^8	1.18 x 10^9

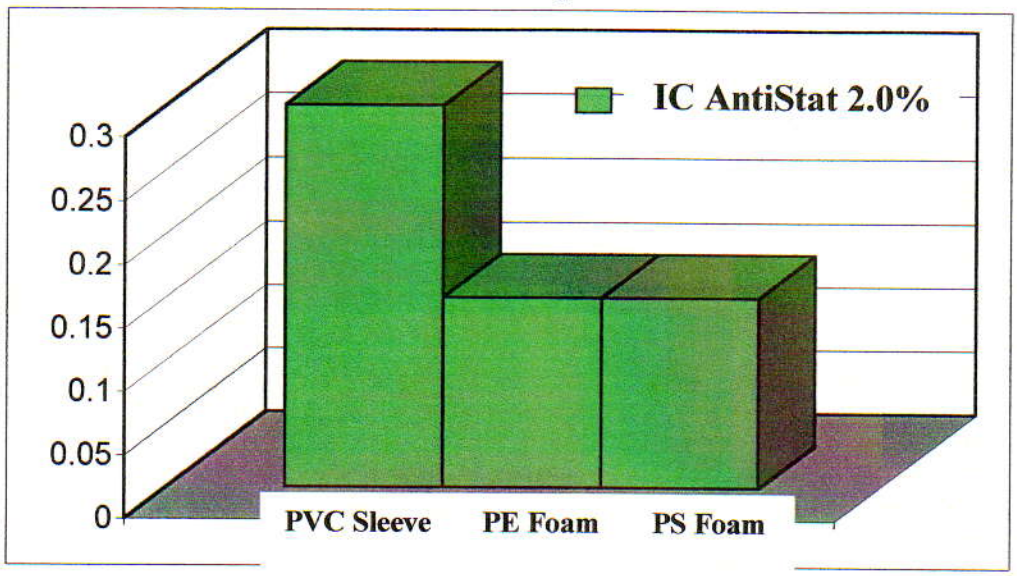
Group a:

#1	0.010	0.010	0.000	0.000	0.01	0.01	0.01	0.01
#3	0.007	0.010	0.005	0.000	0.00	0.02	0.01	0.01
#4	0.010	0.010	0.000	0.000	0.01	0.01	0.01	0.01
#5	0.010	0.010	0.000	0.000	0.01	0.01	0.01	0.01
#6	0.007	0.010	0.005	0.000	0.00	0.02	0.01	0.01

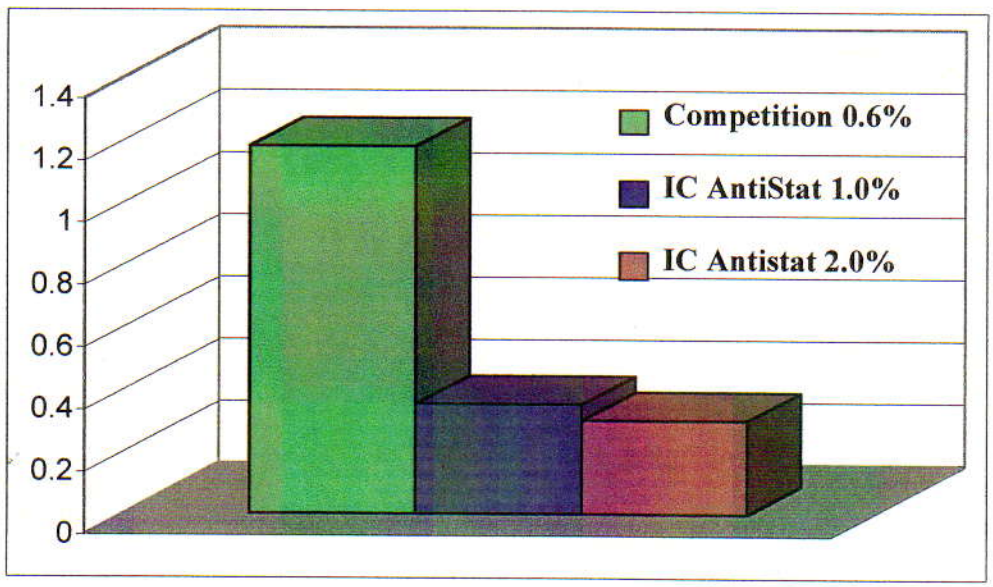
Data Analysis of Groups

Group	Average		Standard Deviation		Range (avg)			
	+5kV	-5kV	+5kV	-5kV	+5kV		-5kV	
A	0.011	0.016	0.002	0.005	0.00	0.02	0.00	0.03
	0.013		0.005		0.00		0.03	
a	0.009	0.010	0.003	0.000	0.00	0.02	0.01	0.01
	0.009		0.002		0.00		0.02	

IC ANTISTAT Antistatic Agent Water Solution Dip Treatment of Plastic Packaging Materials for Electronic Components



IC AntiStat Antistatic Agent Water Solution Dip Treatment of PVC Shipping Sleeves for Electronic Components



IC AntiStat Active Ingredients: N, N-bis (2-hydroxyethyl)-N-(3-dodecyloxy-2-hydroxypropyl) methyl ammonium methosulfate*