Basics of Static Electricity

Static Electricity and Electrostatic Discharge can be a large disruptor of processes within manufacturing facilities. It can cause problems with maintaining product quality, keeping process speeds at optimum levels and the morale of personnel experiencing static shocks.

EXAIR's Basics of Static Electricity white paper will help you learn what causes static electricity and how it develops. Discover what steps can be taken to eliminate static and which products are helpful to control static within your facility.



EXAIR® MANUFACTURING INTELLIGENT COMPRESSED AIR PRODUCTS FOR INDUSTRY SINCE 1983

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A Typical Static Problem in Manufacturing

Goal:
To eliminate static causing an unacceptable scrap rate from a metalized plastic reflector used in automotive lighting.

Problem:
Injection molded parts from PEI Thermoplastic were being direct metalized for use in automotive headlights. Parts were exiting the mold with a static charge and attracting dust prior to metalizing. The static charge and dust on the molded parts resulted in defects within the metalized coating in the form of spider webs and streaks in the coating. Any of these defects caused a rejection of parts and the manufacturer was experiencing close to 100% scrap rates.

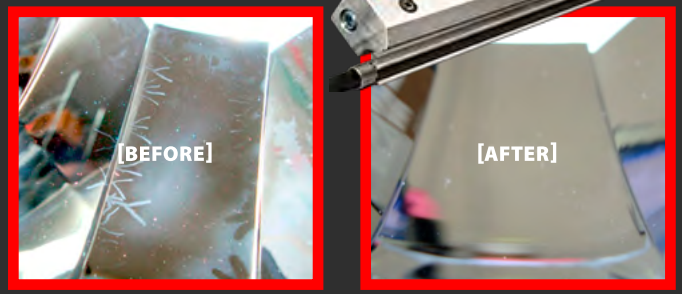
Static Electricity can affect the finish on painted, printed or coated products.

Parts were exiting the mold with a static charge and attracting dust prior to metallizing.

Spiderwebs and streaks caused by static often affect quality in the printing industry when they show up on ink.

EXAIR's Solution

Two Model 112012 12" Super Ion Air Knives

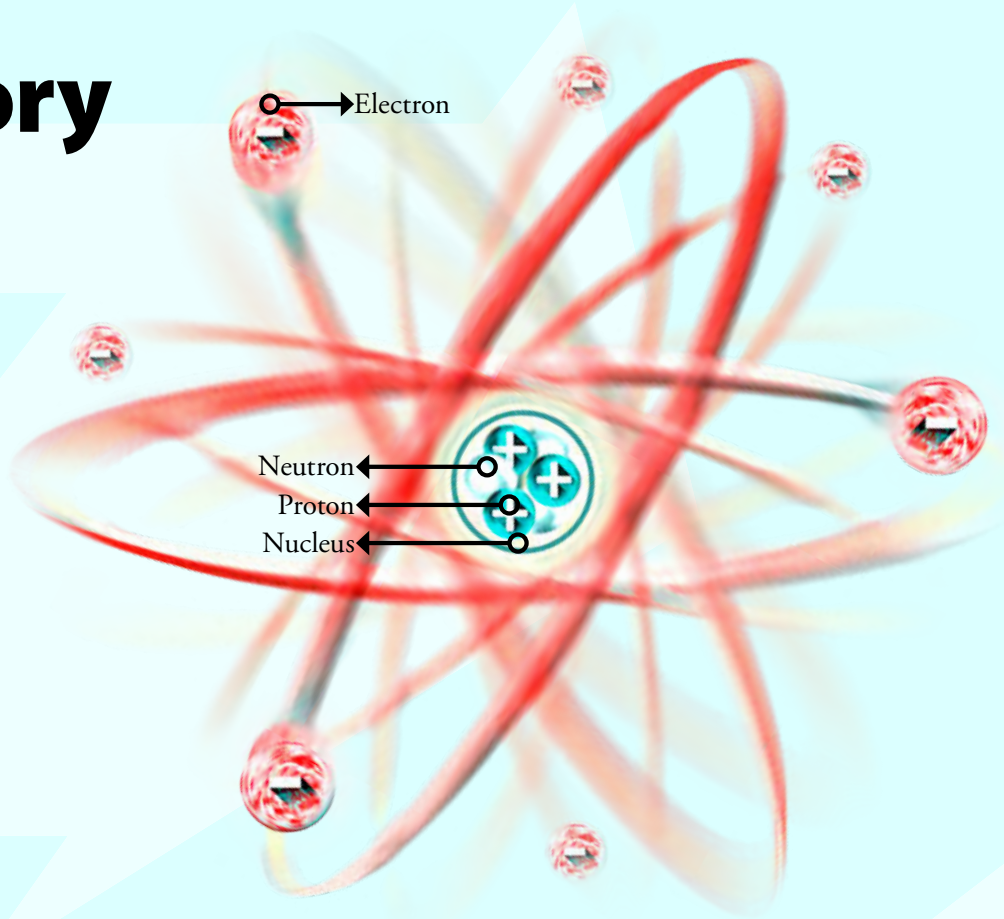


This customer installed two Model 111012 12" Super Ion Air Knives and a power supply to eliminate the static charge and dust on the parts immediately after removal from the injection mold. The knives also helped cool the parts which could then be moved to the metallizing process quicker. Another two 12" Super Ion Air Knives and a power supply were installed to treat the parts immediately before the metallizing process. The result was a perfect reflective finish on the plastic parts and a reduction of the scrap rate to less than 1%.

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Electron Theory

To begin our understanding of static electricity we need to talk in terms of the molecular structure of your material, which is made up of atoms. An atom is a fundamental piece of matter. Everything in the universe is made of atoms. An atom is made up of three tiny particles called subatomic particles: protons, neutrons and electrons. The protons carry a positive charge and reside in the central core of the atom, the nucleus. Surrounding this central core is a group of negatively charged electrons which are bound to the protons through electromagnetic force. This binding force keeps the electrons inside of an electrostatic cloud, with varying degrees of attractive force. The closer an electron is to the nucleus of an atom, the greater the attractive force. Thus, the closer an electron is to the nucleus of an atom, the greater the energy required to make such an electron escape.

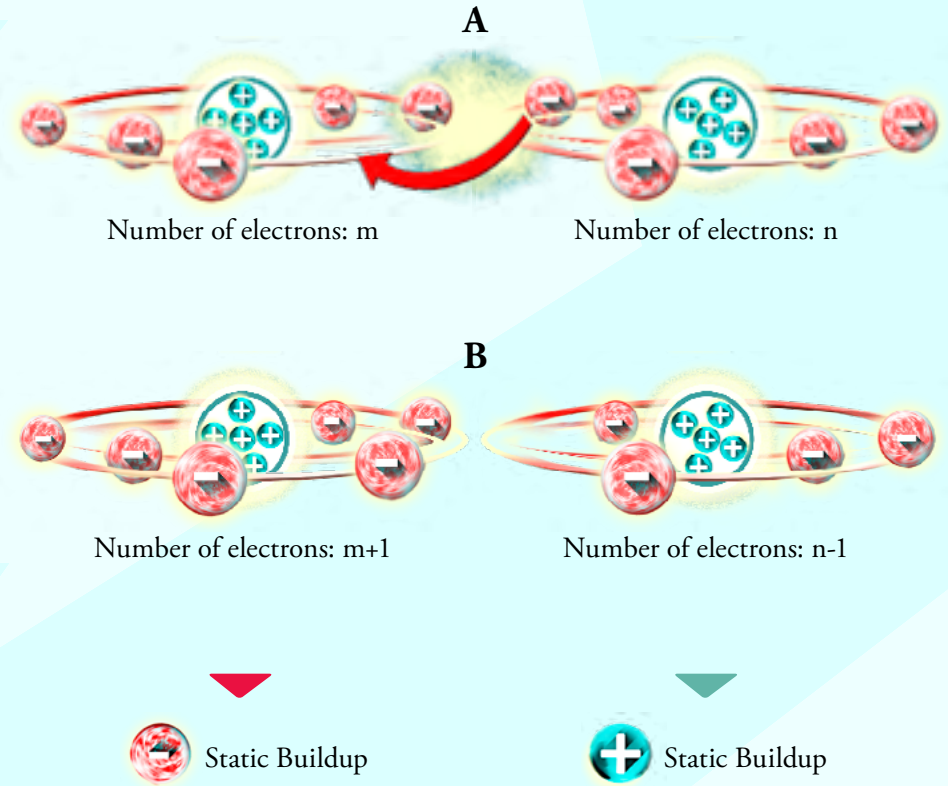


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What Causes Static Electricity?

Static electricity occurs most often on the surface of non-conductive materials but can also occur on ungrounded conductive surfaces. A static (non-moving) electric charge is created whenever two surfaces come into contact and separate, or when friction occurs between them. When two materials are in contact, electrons may move from one material to the other. (Image A) Atoms with weakly bound electrons tend to lose them, while atoms with sparsely filled outer shells tend to gain them. This is known as the triboelectric effect. When the materials come in contact, and then are separated or have friction between them, they retain this charge imbalance. (Image B)

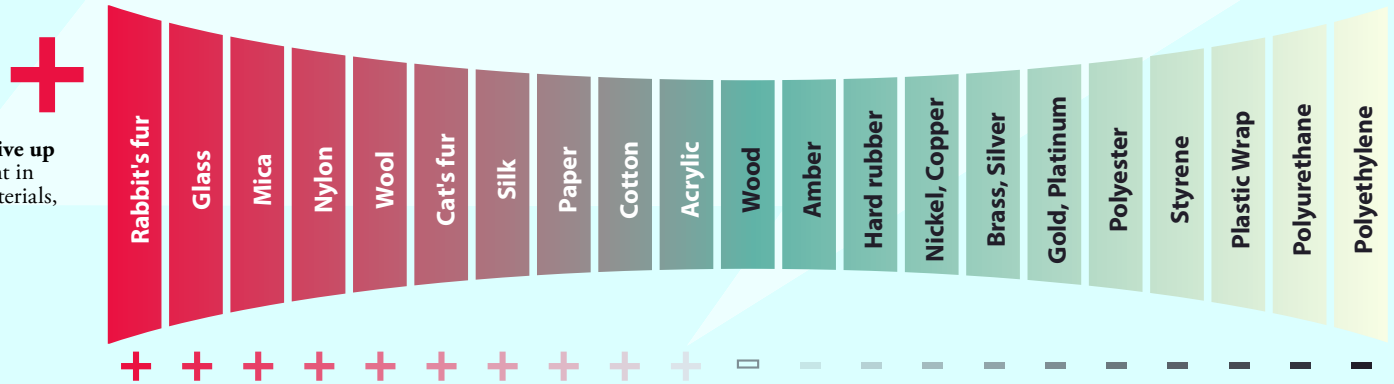
This charge imbalance is where static electricity comes from. Both positive and negative charges will remain static until contacted by or in close proximity to a conductive or grounded surface. The static electricity sparks that are generated between surfaces or people is an example of such flow.



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What Determines the Amount of Static Electricity Imbalance?

We now understand the background behind the generation of static electricity. So, what determines the amount of static electricity generated in any given situation? There are a variety of influencing factors. These include material composition, surface area, environmental conditions and the state of the contact surfaces. The Triboelectric Series chart below shows the static buildup tendencies of various materials. As the distance between the materials becomes greater, the amount of charge becomes larger. As an example, the charge between glass and cotton will be smaller than the charge between glass and polyester.



These materials will **give up** electrons when brought in contact with other materials, especially those that attract electrons.

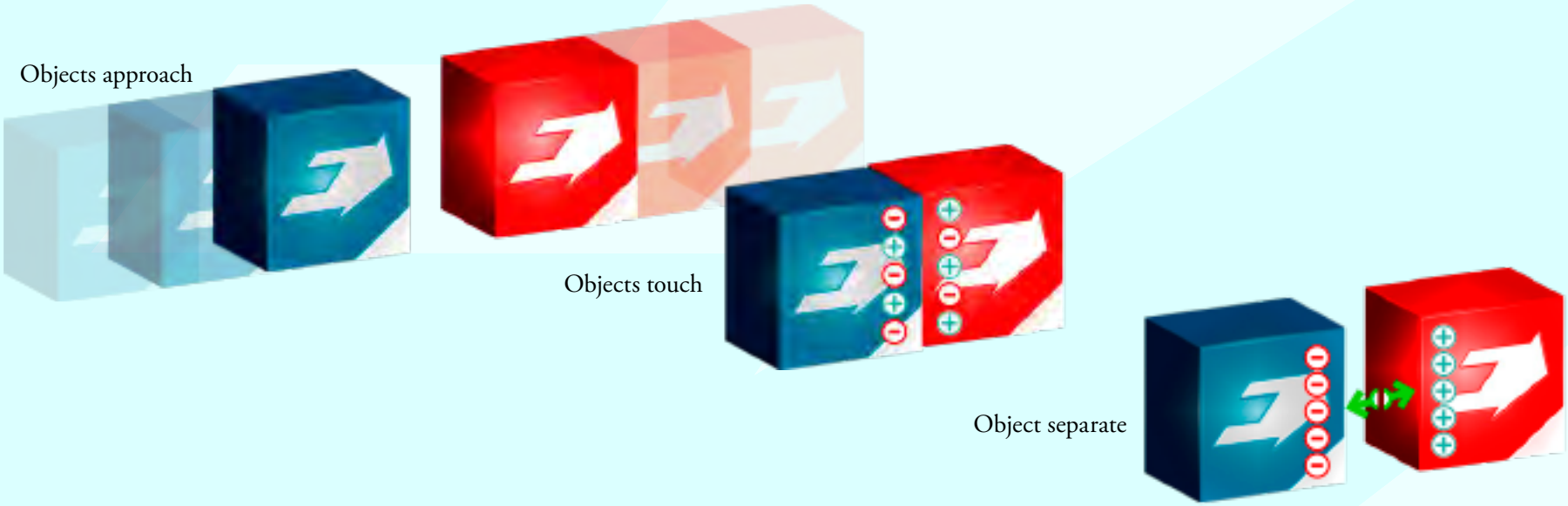
These materials will **attract** electrons when brought in contact with other materials, especially those that give up electrons.

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Types of Static Generation

1 Contact Static Buildup

A static charge can generate from the simplest of processes including two objects touching. This is the case with contact static buildup. A static charge is created from two objects coming in contact with each other and separating, often resulting in an instantaneous static charge. Electrons are transferred from one object to another according to the Triboelectric Series.



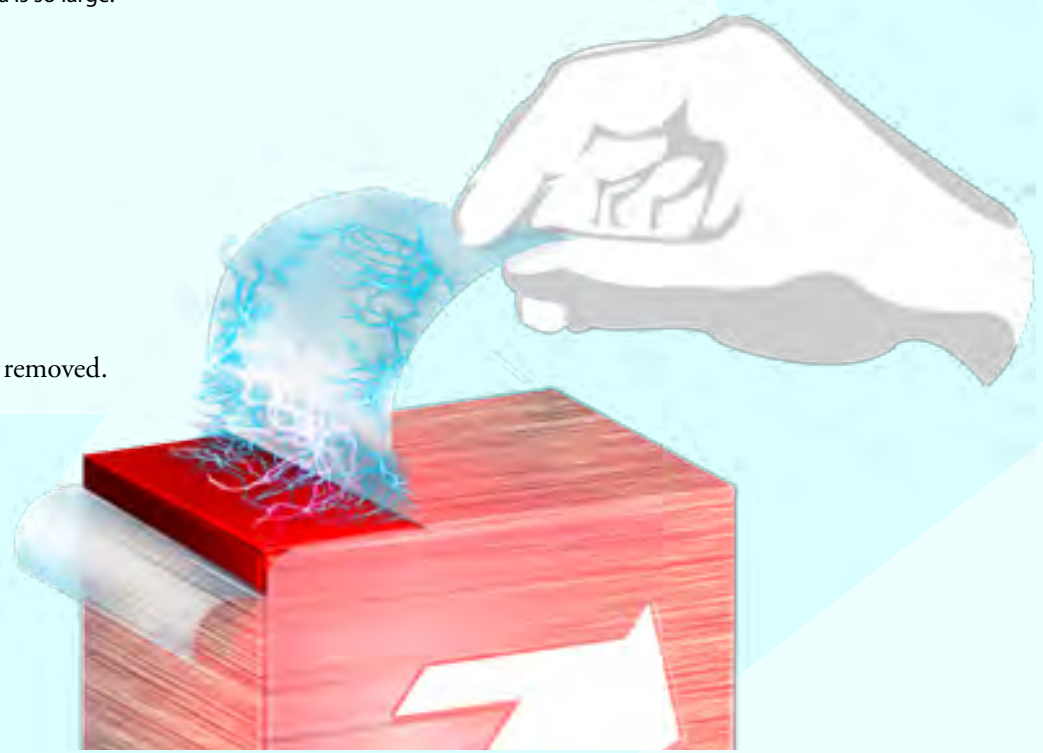
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Types of Static Generation continued

2 Detachment Static Buildup

Occurs when materials like adhesive tape and protective film are removed from another surface. The principle behind this kind of static electricity is the same as contact static buildup. When the two surfaces are separated, not all the electrons are able to get back to their original molecule. Any amount of static electricity detachment generates is significantly larger than contact static buildup, because the contact surface area is so large.

When attached material is removed.



Types of Static Generation continued

3 Frictional Static Buildup

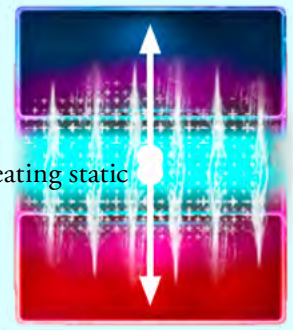
This static buildup is created when two objects have friction between them. The principle behind this type of static electricity is the same as contact static buildup. However, if the friction increases due to increasing force pressing objects together, more molecules come into contact with each other. This will increase the static electricity charge generated. Static charge values caused by friction are also greater than those of contact static buildup.



1 Contact



2 Friction



3 Separation creating static

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How to Control Static Charge Buildup

1 Determine the source of static buildup

The first step in static control is to determine where in the process static charges are being generated. Many times a static charge will be located right where contact, detachment or friction are occurring within your process.

A simple diagnostic tool to determine if static is present is a static meter. This is a hand held instrument that will provide you the polarity and strength of the static charges present. Knowing these values can help determine how to prioritize your plan to eliminate static by neutralizing the areas with the highest charges before areas of low charge.

It can also be used to measure the effectiveness of any static control product or treatment which has been implemented by simply comparing the static values before and after the installation of a static control solution.



CE

Model 7905 Digital Static Meter

The EXAIR Digital Static Meter allows for easy, one-hand static measurements. In most cases, the highest voltage reading will indicate the surface problem. Sensitive and responsive, it indicates the surface voltage and polarity on objects up to ±20 kV when measured one inch (25mm) away.

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How to Control Static Charge Buildup continued



2 Eliminate or minimize the source causing a static charge

Having identified the source of static, consider eliminating, minimizing or treating the source generating the charge.

- Replace non-conductive points of contact with conductive materials connected to earth ground. Webs threaded around a series of rubber rollers will generate all three types of static generation; contact, frictional, and separation. Replacing them with grounded conductive rollers will eliminate static buildup.
- Prevent parts from rubbing against themselves or other non-conductive surfaces. Replace plastic guide rails with conductive rails. Pick up and lay down plastic sheets rather than sliding them off a stack and sliding them onto a table.
- Increase relative humidity. When relative humidity increases, the surfaces and materials in a given environment can absorb the moisture in the air or they will form a very thin surface layer of moisture which dissipates accumulated static charges. When relative humidity is low, static increases. This is why static increases in dry, winter months and decreases in humid, summer months.



Model AT5010SS Atomizing Nozzle

1/2 NPT internal mix 360° nozzles are designed for applications where the spray pattern must be oriented away from the nozzle in all directions. These larger 360° nozzles are ideal to provide humidification over a broad area.

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How to Control Static Charge Buildup continued

3 Treating Static Buildup

It is not always possible to eliminate the sources of static buildup. In those cases, ionization treatment is required. Ionization is the process of converting an atom or molecule into an ion by adding or removing electrons. This is done by applying high voltage onto sharp emitter points.

EXAIR's shockless ionizers use a 5000 VAC transformer to supply power to an emitter point. On the positive phase of the cycle, electrons are stripped from air molecules in the vicinity. On the negative phase, electrons are added to air molecules in the area. The air molecules are then in an unbalanced state of charge and become what is called an ion. When these ions come into contact with an unbalanced molecule on a charged surface, an exchange of electrons takes place. The air molecule is no longer an ion and the surface molecule is now neutralized (balanced).



Model 8199
Gen4 Ionizing Point

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Products For Removing Static Charge

To improve effectiveness, EXAIR marries its engineered blow off products with ion technology. The use of laminar air flow distributes the ions faster, at further distances, and into somewhat inaccessible areas. EXAIR has a broad range of static eliminating products to serve most any application.

Intellistat® Ion Air Gun™





A patented handheld static eliminator for sterile environments. Ideal for clean rooms in electronics manufacturing, scientific testing facilities, clean rooms and laboratories.

Model #8500 Intellistat Ion Air Gun

A lightweight solution for static and particulate elimination in sensitive processes!

- Rated Class 5 for clean rooms and controlled environments per ISO 14644-1
- Rapid static decay
- Lightweight, dissipative polycarbonate body
- Short-throw, fast acting trigger
- CE and RoHS compliant, UL listed

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OSHA

RoHS COMPLIANT

Intellistat® Ion Air Nozzle™

A patented mountable nozzle for hands free static elimination at assembly stations and benchtop applications!

Rated Class 5 for clean rooms and controlled environments per ISO 14644-1

Model #8505 Intellistat Ion Air Nozzle

This amazing ionizer is EXAIR's latest hands-free innovation in a long line of static elimination solutions. This intelligent product provides a balanced ionized air stream to neutralize static and remove troublesome particulate during sensitive assembly work, test procedures and clean processes. With a +/-30 volt offset, the Intellistat nozzle was designed to use minimal compressed air while delivering a focused blowoff and exceptional static decay rates capable of reducing 1000 volts to 100 volts in 0.6 seconds. The design includes an efficient, low voltage transformer which converts 120VAC to 24V DC to assure safety. An EXAIR engineered air nozzle delivers the air well below the OSHA standards for noise exposure and dead-end pressure, which maintains safety compliance.

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GEN4™ Super Ion Air Knife™

For a flat sheet of ionizing air, the Ion Air Knife offers superior performance with low air consumption. They operate at a surprisingly quiet 50 dBA for most applications and can be effective at distances up to 20 feet. Force and flow can be regulated to best fit the applications. Stock lengths up to 108" are available for wide area coverage.

Plant Engineering PRODUCT of the YEAR Finalist 1998

Model 1122108DX 108" (2743mm) Super Ion Air Knife

The Super Ion Air Knife provides a laminar sheet of air over areas from 3" to 108" wide. In this application it removes static and dust from a polycarbonate sheet immediately before a protective layer is applied. Super Ion Air Knives are built from the most efficient compressed air **powered air knife available.**

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Gen4™ Ion Air Cannon™

EXAIR's Ion Air Cannon neutralizes static electricity and cleans at distances up to 15 feet with no moving parts. It is ideal for those hard to reach spaces or confined areas that require a concentrated flow of static eliminating ions. Also a good solution for benchtop applications.

Model 8192 Ion Air Cannon

This Ion Air Cannon removes a static charge from bottles prior to filling. Before installing the Ion Air Cannon, the static charge would attract dust to the opening and inside of the bottle. Ion Air Cannons are also a great benchtop solution.

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GEN4™ Ion Air Gun™

Plant Engineering PRODUCT of the YEAR Finalist 2016

For manual applications, EXAIR's Ion Air Gun combines incredibly fast static decay rates with low compressed air consumption. It is the ideal way to remove static, contaminants and dust from three dimensional parts prior to assembly, packaging, painting or finishing.

Model 8193 Ion Air Gun

An Ion Air Gun is used to remove debris from artwork before it is covered with glass and framed. The Ion Air Gun is the best solution for manual applications while providing comfortable ergonomics and ruggedness.

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GEN4™ Ion Air Jet™

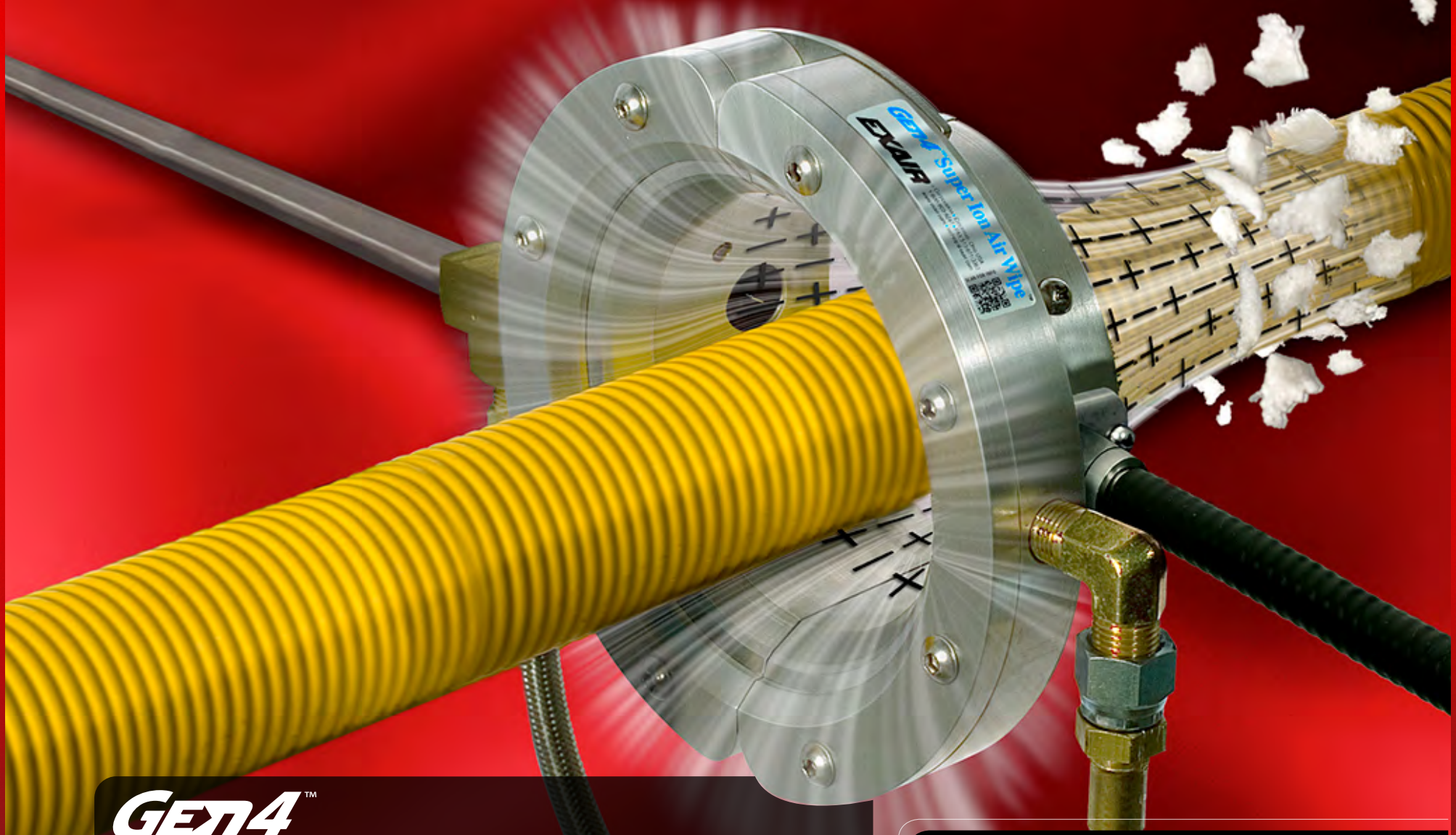
For stationary installation, the Ion Air Jet delivers a concentrated air flow that can cover a precise spot without disturbing other areas. This quiet focused airstream provides fast static decay rates and cleaning ability. The Ion Air Jet is the ideal way to remove static and dust from small parts prior to shrink wrapping, packaging, printing, painting or finishing.



Model 8194 Ion Air Jet

EXAIR's Ion Air Jet removes static and debris from the neck of a bottle before a shrink wrap safety seal is placed on it. The Ion Air Jet is a small profile product which fits in tight mounting areas when space is at a premium. It is available with or without a magnetic base mounting system.

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Gen4™ Super Ion Air Wipe™

EXAIR's Super Ion Air Wipe provides a uniform 360 degree ionized airstream that is easy to clamp around a part for eliminating static electricity and contaminants. It is ideal for use on pipe, cable, extruded shapes, hose, wire and more. It maximizes airflow while minimizing compressed air consumption.

Model 8164 Super Ion Air Wipe

The Super Ion Air Wipe provides total coverage of the part moving through it. The high volume, high velocity flow attaches itself to the surface and wipes it down with the static eliminating ions. The Super Ion Air Wipe is the easy way to provide 360˚ coverage around a continuously moving part. The hinged design, allowing the air wipe to open, makes threading continuous wire, tube or extrusions unnecessary.

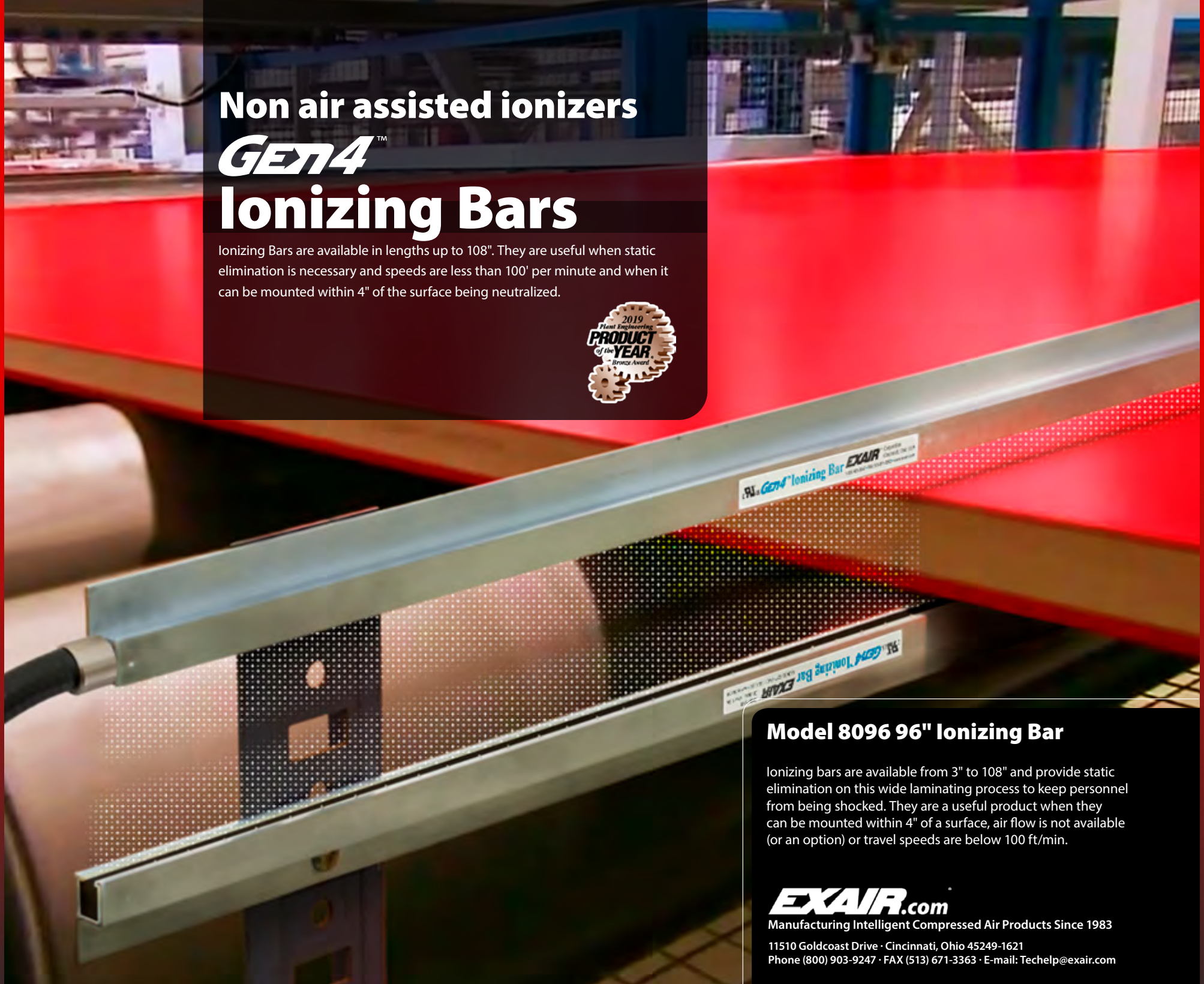
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Non air assisted ionizers

GEN4™ Ionizing Bars

Ionizing Bars are available in lengths up to 108". They are useful when static elimination is necessary and speeds are less than 100' per minute and when it can be mounted within 4" of the surface being neutralized.

2019 Plant Engineering PRODUCT of the YEAR Bronze Award



Model 8096 96" Ionizing Bar

Ionizing bars are available from 3" to 108" and provide static elimination on this wide laminating process to keep personnel from being shocked. They are a useful product when they can be mounted within 4" of a surface, air flow is not available (or an option) or travel speeds are below 100 ft/min.

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Non air assisted ionizers

GEN4™ Ionizing Point™

EXAIR's Ionizing Point is a compact, single point ionizer (no air required) ideal for winding, rewinding and slitting operations. They can also be mounted inside ductwork.

The shockless Ionizing Point delivers a high concentration of positive and negative ions for fast static decay. It can neutralize any surface within 2".

Model 8199 Ionizing Point

Ionizing Points provide pinpoint static elimination. This application is removing static from a paper slitting operation.

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New

EXAIR VARISTAT Benchtop Ionizer™

Mountable hands-free blower for static elimination at assembly stations and benchtop applications.

The EXAIR Varistat Benchtop Ionizer is a blower style static eliminator designed to neutralize static charges on surfaces in demanding industrial settings where static can become troublesome. With the help of ionizing technology, the Varistat supplies a constant stream of ion-balancing airflow to keep products static-free and particulate-free with hands-free operation and without the need of compressed air. Manually adjustable, the Varistat provides full coverage static elimination for workbenches, part assembly, web cleaning and more.



Model 8600 Varistat Benchtop Ionizer

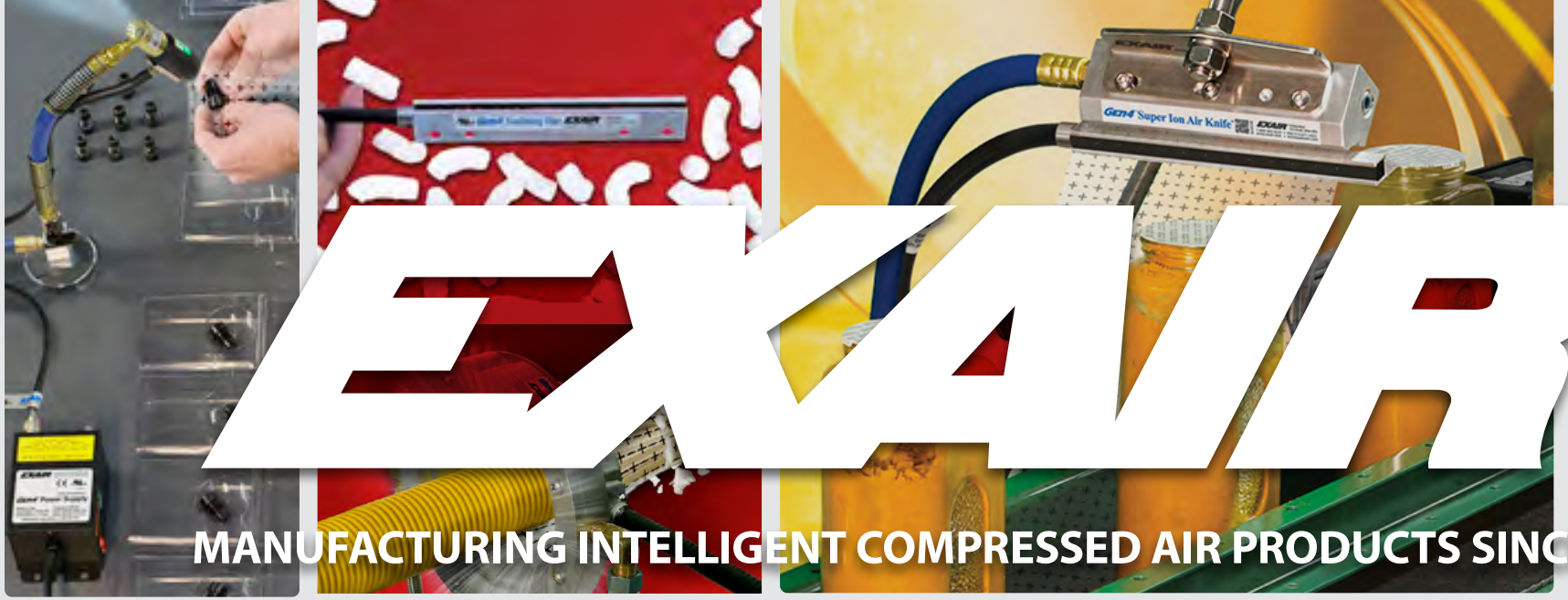
Applications

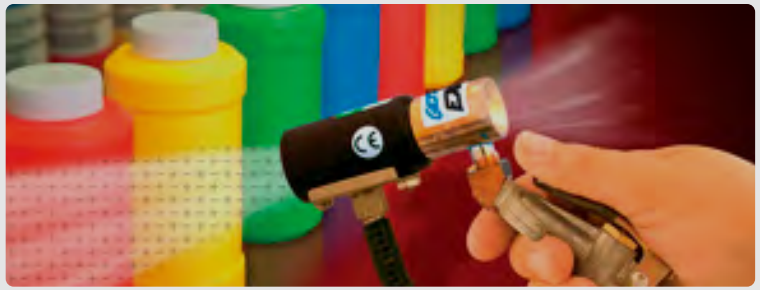
- Web cleaning
- Electronics assembly
- Molding machinery
- Slitting, sheeting and winding
- Cleaning parts
- Shrink wrappers
- Package cleaning
- Printing equipment
- Benchtop assembly

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Summary

Understanding the nature of static electricity is the first step in controlling it. Keep in mind that static occurring on non-conductive materials resists the flow of electrons, so simply attaching a ground strap will not work. Every molecule on the surface has to come in contact with a conductive material or an ion. Those that don't will retain their charges.

EXAIR has a full line of static eliminators that will service most any application. We also have a 30 day unconditional guarantee for US and Canadian customers, which enables you to get a system in house and test it out.

Technical Support

EXAIR has a staff of Application Engineers ready to assist you in selecting the appropriate model for your application.

They can be contacted at **1-800-903-9247.**
Or you can email them at ***techelp@exair.com***

References

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https://exair.co/bose_wiki_triboelectric
Author: John Zavisa for How Stuff Works: How Van de Graaff Generators Work
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https://exair.co/bose_triboelectric-charging