

## Triboelectric Series

Electrostatic discharge (ESD), which is the rapid transfer of electrostatic charge between two objects that can result in damage to products, arises from charge build-up that occurs as a result of an imbalance of electrons on the surface of a material. Such a charge build-up develops an electric field that has measurable effects on other objects at a distance.

The process of electron transfer as a result of two objects coming into contact with each other and then separating is known as 'triboelectric charging'. The prefix 'tribe' means 'to rub.' The process of triboelectric charging results in one object gaining electrons on its surface, and therefore becoming negatively charged, and another object losing electrons from its surface, and therefore becoming positively charged.

Some atoms hold on to their electrons more tightly than others do. How strongly matter holds on to its electrons determines its place in the **triboelectric series**. If a material is more apt to give up electrons when in contact with another material, it is more positive in the triboelectric series. If a material is more apt to "capture" electrons when in contact with another material, it is more negative in the triboelectric series.

The **triboelectric series** is a list that ranks various materials according to their tendency to gain or lose electrons. It usually lists materials in order of decreasing tendency to charge positively (lose electrons), and increasing tendency to charge negatively (gain electrons). Somewhere in the middle of the list are materials that do not show strong tendency to behave either way. Note that the tendency of a material to become positive or negative after triboelectric charging has nothing to do with the level of conductivity (or ability to discharge) of the material.

The triboelectric series shown in Table 1.

**Table 1.** The Triboelectric Series

<b>Most Positive (+)</b>		
Air	+++	
Human Hands, Skin		
Asbestos		
Rabbit Fur		
Glass		
Human Hair		
Mica		
Nylon		
Wool		
Lead		
Cat Fur		+
Silk		
Aluminum		
Paper		
Cotton		
Steel	-	
Wood		
Lucite		
Sealing Wax		
Amber		
Rubber Balloon		
Hard Rubber		
Mylar		
Nickel		
Copper		
Silver		
uv Resist		
Brass		
Synthetic Rubber		
Gold, Platinum		
Sulfur		
Acetate, Rayon		
Polyester		
Celluloid		
Polystyrene		
Orlon, Acrylic		---
Cellophane Tape		
Polyvinylidene chloride (Saran)		
Polyurethane		
Polyethylene		
Polypropylene		
Polyvinylchloride (Vinyl)		
Kel-F (PCTFE)		
Silicone		
Teflon		

Silicone Rubber

**Most Negative (-)**