Electroluminescence

The result of radiative recombination of electrons and holes in a material. The excited electrons release their energy as photons – light.

LED – prior to recombination, electrons and holes are separated by doping the material to form a p-n junction

EL Lamps – excitation by impact of high-energy electrons accelerated by a strong electric field, electron-hole pairs release light when they recombine
Electroluminescent (EL) Manufacturing Process

As AC power is applied to the conductive surfaces, an electric field is generated across the phosphor and dielectric layers. Twice during each cycle electron-hole pairs recombine and emit light through the transparent front electrode layer.
Typical Printed EL Lamp Construction

Microencapsulated Phosphor in a Hydrophobic Binder System

Polyester Film (PET)

Indium Tin Oxide (In$_2$O$_3$SnO$_2$)

Front Electrode Busbar (Ag)

Phosphor Layer (ZnS:Cu)

Dielectric Layer (2) (BaTiO$_3$ & TiO$_2$)

Rear Electrode & Busbar (Carbon)

Laminate (PP)
<table>
<thead>
<tr>
<th>Substance Name</th>
<th>CAS No.</th>
<th>Mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene Terephthalate</td>
<td>25038-59-9</td>
<td>10.6598 gms.</td>
</tr>
<tr>
<td>In2O3:SnO2</td>
<td>50926-11-9</td>
<td>0.0107 gms.</td>
</tr>
<tr>
<td>Polyethylene Terephthalate</td>
<td>25038-59-9</td>
<td>0.0000 gms.</td>
</tr>
<tr>
<td>In2O3:SnO2</td>
<td>50926-11-9</td>
<td>0.0000 gms.</td>
</tr>
<tr>
<td>Polypropylene Cross Linked Acrylic Resin</td>
<td>9003-07-0</td>
<td>2.4764 gms.</td>
</tr>
<tr>
<td>Aluminum Oxide Hydride</td>
<td>24623-77-6</td>
<td>0.0646 gms.</td>
</tr>
<tr>
<td>Silver (Flake)</td>
<td>7440-22-4</td>
<td>0.0000 gms.</td>
</tr>
<tr>
<td>Acrylic Co-Polymer &amp; PVDF</td>
<td>9011-14-7</td>
<td>0.0000 gms.</td>
</tr>
<tr>
<td>Acrylic Co-Polymer &amp; PVDF</td>
<td>9011-14-7</td>
<td>0.0000 gms.</td>
</tr>
<tr>
<td>ZnS:Cu</td>
<td>1314-98-3</td>
<td>1.2461 gms.</td>
</tr>
<tr>
<td>Acrylic Co-Polymer &amp; PVDF</td>
<td>9011-14-7</td>
<td>0.3801 gms.</td>
</tr>
<tr>
<td>Acrylic Co-Polymer &amp; PVDF</td>
<td>9011-14-7</td>
<td>0.0000 gms.</td>
</tr>
<tr>
<td>Graphite</td>
<td>7782-42-5</td>
<td>0.2029 gms.</td>
</tr>
<tr>
<td>Carbon</td>
<td>133-86-4</td>
<td>0.0338 gms.</td>
</tr>
<tr>
<td>Acrylic Co-Polymer &amp; PVDF</td>
<td>9011-14-7</td>
<td>0.1015 gms.</td>
</tr>
<tr>
<td>Acrylic Co-Polymer &amp; PVDF</td>
<td>9011-14-7</td>
<td>0.0000 gms.</td>
</tr>
<tr>
<td>Silver (Flake)</td>
<td>7440-22-4</td>
<td>0.0790 gms.</td>
</tr>
<tr>
<td>Acrylic Co-Polymer &amp; PVDF</td>
<td>9011-14-7</td>
<td>0.0614 gms.</td>
</tr>
<tr>
<td>Acrylic Resin</td>
<td></td>
<td>0.0000 gms.</td>
</tr>
<tr>
<td>Acrylic Co-Polymer &amp; PVDF</td>
<td>9011-14-7</td>
<td>0.0000 gms.</td>
</tr>
<tr>
<td>Acrylic Co-Polymer &amp; PVDF</td>
<td>9011-14-7</td>
<td>0.0000 gms.</td>
</tr>
</tbody>
</table>

Est. % Solids by Weight: 50.0%

TOTAL CALCULATED: 17.652 gms.
Variables for Light

![Graph showing EL Lamp Brightness vs Voltage for different frequencies (60Hz, 200Hz, 400Hz, 600Hz, 1KHz). The y-axis represents brightness in footlambert (FL) and the x-axis represents voltage. The graph illustrates how brightness increases with voltage for each frequency.]
EL Lamp Benefits

- Most energy efficient form of light
- Only light that produces **NO** heat
- Will not catastrophically fail, durable and dependable
- Minimal casting of shadows, no glare
- Maintains even luminance across lamp face
- Highest visibility through smoke & fog, no halo-effect.
- High readability at any viewing angle, distributed light source
- Easy to look at without straining the eye
- Most environmentally friendly from cradle to grave
- Can be produced in almost any color, green matches peak sensitivity of the human eye
- Characterized by Luminance vs. Illumination
New Applications

Light panels for grid ceilings
(uses less than 3.5 watts of energy)

Building Security and Night Lighting
(uses less than 2 watts of electricity)
Aviation Industry Applications:

Nautical Industry Applications:
The Adaptive Controller can be programmed to increase sign brightness when smoke is detected.
In conclusion, even with limited data points, the EI Products electro luminescent exit sign consistently out performed the other test exit signs with higher luminance readings in both 50 ft and 100 ft tests, particularly to the baseline conditions of no smoke and when the simulated smoke first obstructs the sign.
LED Exit Sign Warranty

STATEMENT OF LIMITED WARRANTY
FOR ACUITY BRANDS LIGHTING, INC.
d/b/a LITHONIA LIGHTING
EMERGENCY PRODUCTS
FOR SHIPMENTS WITHIN THE UNITED STATES AND CANADA
10/01/12

Subject to the exclusions set forth below, Acuity Brands Lighting, Inc. d/b/a Lithonia Lighting (“Acuity”) warrants its emergency fixtures and/or emergency batteries (“Product(s)”) to be free from defect in material and workmanship for the respective time periods set forth in the applicable table below, from the date of shipment from Acuity’s facilities (the “General Warranty”). An emergency battery (“Battery”), whether sold separately, as part of an emergency fixture (“Emergency Fixture”) or as part of another Acuity product, will be considered defective only if it fails to perform for a full 90 minutes during required annual testing. The Emergency Warranty applies only when (1) Emergency Fixtures or other Acuity products containing Batteries have been continuously connected to an AC input power source, or (2) Batteries sold separately have been placed in fixtures continuously connected to an AC input power source, in each case within 90 days of the date of purchase. Incandescent lamps and fuses are not warranted. For Products that incorporate the FIDO™ wireless retrieval system (the “FIDO System”), only the radio and router components (“Gateway”) of the FIDO System are covered by this General Warranty. The General Warranty, as it applies specifically to Gateways, is limited to a period of five (5) years from the date of shipment.

EMERGENCY FIXTURE TABLE

<table>
<thead>
<tr>
<th>Emergency Fixture</th>
<th>Warranty Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exit Signs not specifically shown below</td>
<td>5 years</td>
</tr>
<tr>
<td>Hazardous Location Exit Signs</td>
<td>3 years</td>
</tr>
<tr>
<td>Self-Luminous Exit Signs</td>
<td>Vandal-Resistant frame: 3 years</td>
</tr>
<tr>
<td></td>
<td>Tritium components: 10 or 20 years, depending upon option selected</td>
</tr>
<tr>
<td>Emergency Lighting Unit not specifically shown below</td>
<td>3 years</td>
</tr>
<tr>
<td>Quantum LED Emergency Unit</td>
<td>5 years</td>
</tr>
</tbody>
</table>
Pick the right tool for the job; or it may cost much more than expected!
LED Warranty

STATEMENT OF LIMITED WARRANTY
FOR ACUITY BRANDS LIGHTING, INC.
LED COMMERCIAL INDOOR PRODUCTS
FOR SHIPMENTS WITHIN THE UNITED STATES AND CANADA
10/01/12

Subject to the exclusions set forth below, Acuity Brands Lighting, Inc. ("Acuity") warrants its commercial indoor light emitting diode (LED) fixtures, including the LED arrays and the LED drivers and integral control devices ("Product(s)") to be free from defect in material and workmanship (the "General Warranty") for a period of five (5) years from the date of shipment from Acuity's facilities. The LED arrays in the Product(s) will be considered defective in material or workmanship only if a total of 15% or more of the individual light emitting diodes in the Product(s) fail to illuminate.

Ballasts, lamps, emergency batteries and poles are excluded from the General Warranty. Holophane® and Accucap® brand ballasts, Acculamp® brand lamps, emergency batteries, and poles are warranted separately; and the terms of such warranties are located at www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx. Manufacturers of ballasts, lamps, emergency batteries and poles incorporated into the Product(s) are solely responsible for any costs or expenses related to any claims, repairs, or replacements associated with any such component(s). Assistance with warranty claims for any such component(s), and copies of each applicable manufacturer's warranty, may be obtained from an authorized Acuity post-sales or customer service representative.

This Statement of Limited Warranty ("Warranty") applies only when the Product(s) are installed in applications in which ambient temperatures are within the range of specified operating temperatures and are operated within the electrical values shown on the LED driver Label. Acuity will not be responsible under this Warranty for any failure of the Product(s) that results from external causes such as: acts of nature, physical damage; exposure to adverse or hazardous chemical or other substances; use of reactive cleaning agents and/or harsh chemicals to clean the Product(s); environmental conditions; vandalism; fire; power failure, improper power supply, power surges or dips, and/or excessive switching; induced vibration; animal or insect activity; fault or negligence of purchaser, any end user of the Product(s) and/or any third party not engaged by Acuity; improper or unauthorized use, installation, handling, storage, alteration, maintenance or service, including failure to abide by any product classifications or certifications, or failure to comply with any applicable standards, codes, recommendations, product specification sheets, or instructions of Acuity; use of the Product(s) with products, processes or materials supplied by any end user or third party; or any other occurrences beyond Acuity's reasonable control. Acuity also will not be responsible under this Warranty for any substantial deterioration in the Product finish that is caused by failure to clean, inspect or maintain the finish of the Product(s). If the Product(s) are used on existing foundations, anchorages or structures, the end user is solely responsible for the structural integrity of such existing foundations, anchorages or structures and all consequences arising from their use. Adequate records of operating history, maintenance, and/or testing must be kept by the end user and provided to Acuity upon request to substantiate that the Product(s) have failed to comply with the terms of this Warranty. Neither polycarbonate nor acrylic material used in the Products is warranted against yellowing, as yellowing may naturally occur over time due to normal aging. The Product(s) are not warranted against costs that may be incurred in connection with changes or modifications to the Product(s) required to accommodate site conditions and/or faulty building construction or design. In addition, the Product(s) are not warranted against cost resulting from installation of a third party components, failures of third party supplied components, or failures of Acuity supplied Product(s) caused by a third party supplied component. This Warranty only applies to the Product(s) when sold for commercial purposes and does not apply to any consumer product(s), all of which are governed by separate limited warranty terms. For the avoidance of doubt, Acuity emergency fixtures are not covered by this Warranty.

If the Product(s) fail to comply with the terms of this Warranty, Acuity, at its option, will repair or replace the Product(s) with the same or a functionally equivalent Product(s) or component part(s). This Warranty excludes labor and equipment required to remove and/or reinstall original or replacement parts. This Warranty extends only to the Product(s) as delivered to, and is for the sole and exclusive benefit of, the original end user of the Product(s) at the original location. This Warranty may not be transferred or assigned by the original end user. The repair or replacement of any Product(s) or component part within the Product(s) is the sole and exclusive remedy for failure of the Product(s) to comply with the terms of this Warranty and does not extend the Warranty period. Warranty claims regarding the Product(s) must be submitted in writing within (30) days of discovery of the defect or failure to an authorized Acuity post-sales or customer service representative. Product(s) or component part(s) may be required to be returned for inspection and verification of non-conformance by Acuity, but no Product(s) or component part(s) will be accepted for inspection, verification or return unless accompanied by a "return authorization number" which can be obtained only from an authorized Acuity post-sales or customer service representative. Acuity is not responsible for any costs and expenses incurred in connection with shipment of Product(s) to Acuity, but Acuity shall bear all cost and expense incurred in connection with shipment of replacement Product(s) to the customer.
LED Warranty

SCHEDULE C

TOTAL PERFORMANCE SYSTEM WARRANTY
GE Lighting Solutions, LLC ("GE") is pleased to provide the following warranty for the periods shown below. This warranty covers GE Tetra® LED components operated on a GE Tetra power supply when installed by ______________________ (Insert name of Installation Company).

Combination Tetra LED Component and Tetra Power Supply System Limited Warranty

GE warrants each GE Tetra LED component installed on a GE Tetra power supply to comply with its respective published specifications, to be free from defects in material, workmanship, title, and to operate from the date of manufacture for the time periods and subject to the Terms and Conditions specified below. If a GE Tetra LED component fails to operate for the warranty period, GE will provide a free replacement component in accordance with the Terms and Conditions set forth below. If a GE Tetra power supply fails to operate within the warranty period, GE will provide a free replacement power supply in accordance with the Terms and Conditions set forth below.

*Warranty Period is based on typical 8,760 hr./yr. operation on a continuous burning cycle of 24 hours, at maximum operating and environmental conditions; other operating cycles may affect warranty period. Contact your GE Representative for details. **XX = Color for Tetra BT (RD=Red, YL=Yellow, LG=Lime Green, GL=Green, BL=Blue, WH=White)

TERMS AND CONDITIONS
This warranty only applies when GE Tetra LED components and GE Tetra power supply are properly wired and installed together as a system; are operated within the electrical values shown on the GE Tetra power supply label; used in lighting equipment designed and approved for the application and in environmental conditions (temperature, humidity) within the normal specified operating range of the system. This warranty does not apply to any abnormal use or use in violation of any applicable standard, code or instructions for use in installations including those contained in the latest National Electrical Code (NEC), the Standards for Safety of Underwriters Laboratory, Inc. (UL), Standards for the American National Standards Institute (ANSI), in Canada, the Canadian Standards Association (CSA), Europe (CE), Australia (C-Tick). This warranty will not apply in the event of conditions demonstrating abnormal use or stress, including under/over voltage conditions, excessive switching cycles

REPLACEMENT OF PRODUCT, LIMITS OF LIABILITY
The foregoing shall constitute the exclusive remedy of the purchaser and the sole liability of GE for GE Tetra LED components and GE Tetra power supply warranties. (NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE IS MADE OR IS TO BE IMPLIED). In no event shall GE be liable for any other costs or damages, including lost profits or revenues, incidental, special or consequential damages.
**EL vs. Photoluminescent Sign**

Visibility in **Same** Smoke Condition

E.I. Technologies’ Series 16

Photoluminescent Fully Charged