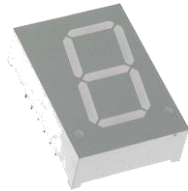
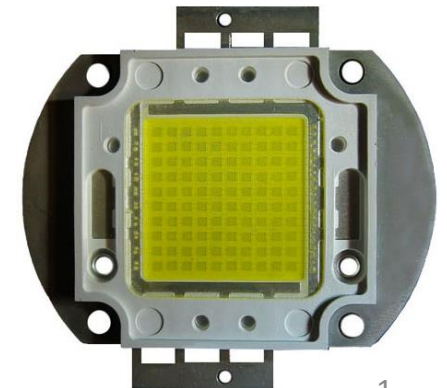
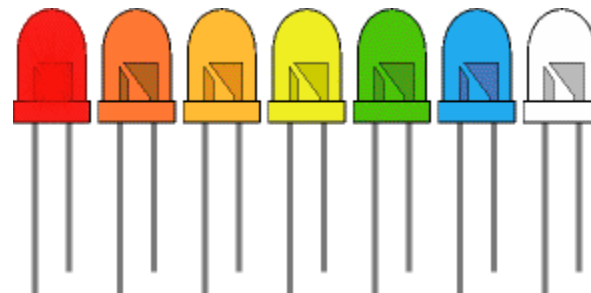


# ELECTRONICA GENERAL



**LED**

*Diodo Emisor de Luz*

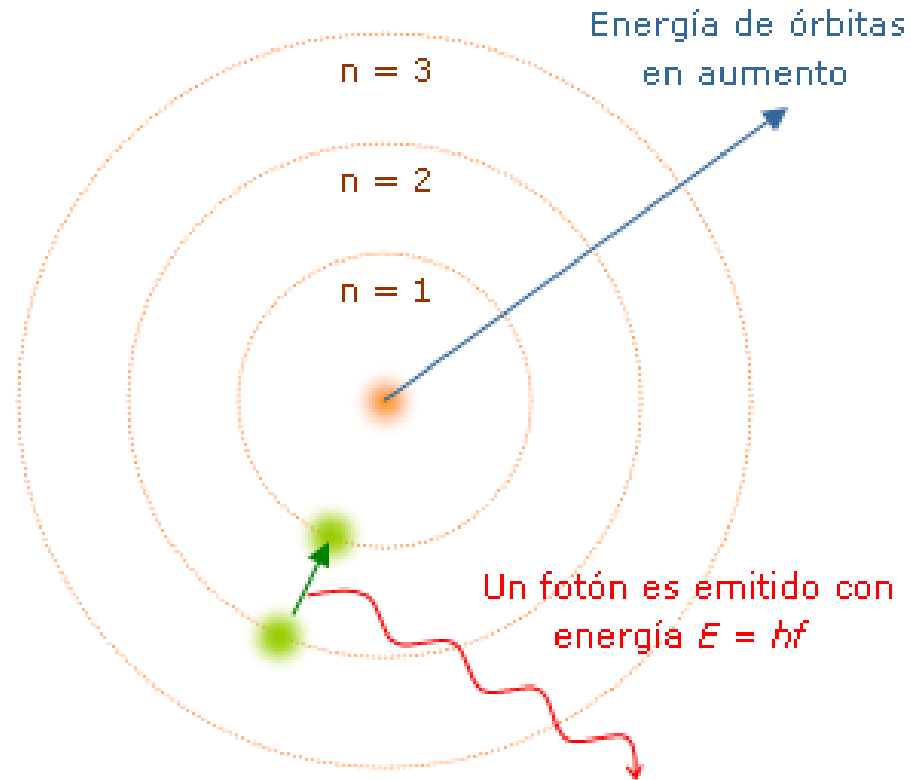


**Mgtr. Ing. Victor Hugo Kurtz**

# LED

- El término **LED**, acrónimo inglés de (*Light Emitting Diode*) Diodo Emisor de Luz.
- Basan su funcionamiento, en la propiedad de algunos materiales semiconductores, de emitir luz cuando son atravesados por una corriente eléctrica.
- **El LED es un diodo que produce luz visible, invisible (infrarroja, ultravioleta) cuando se encuentra polarizado en directa.** >

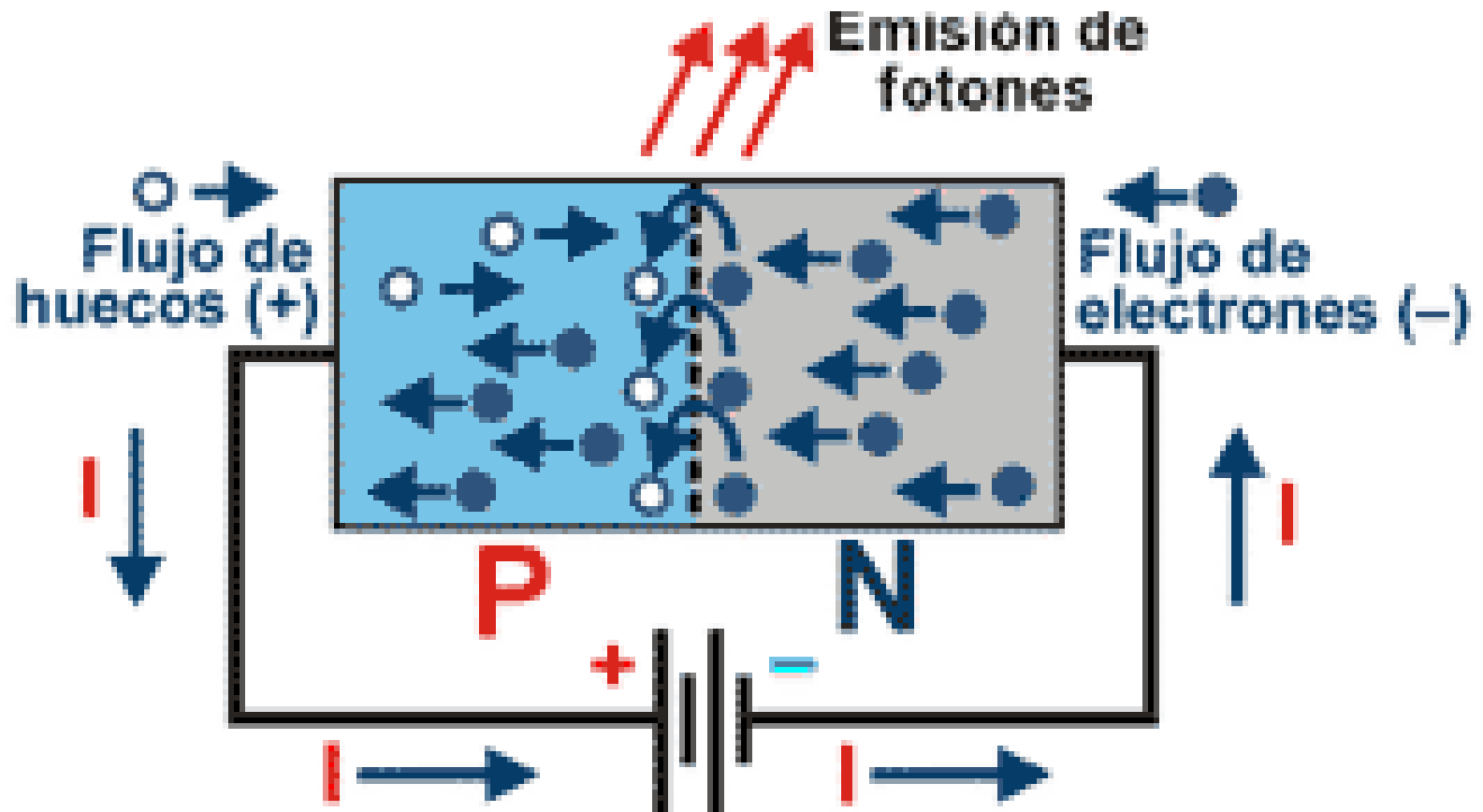
# Modelo Atómico de Bohr



Referencia:

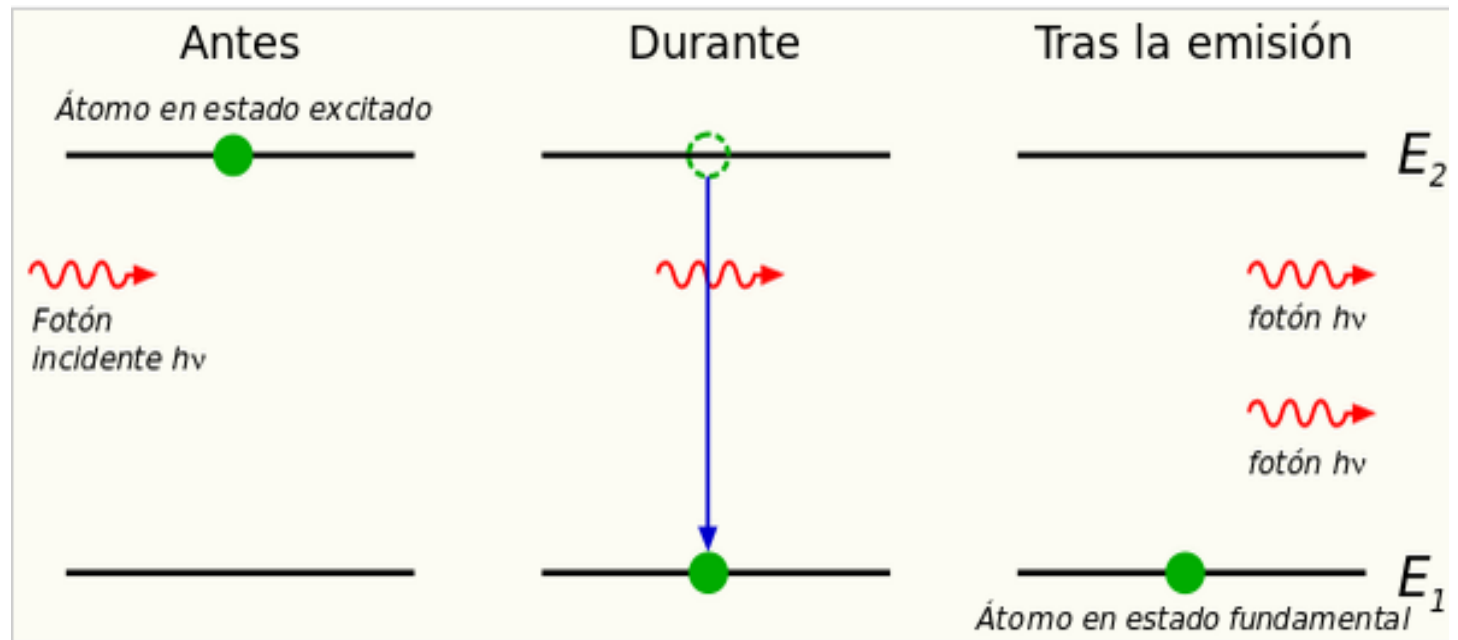
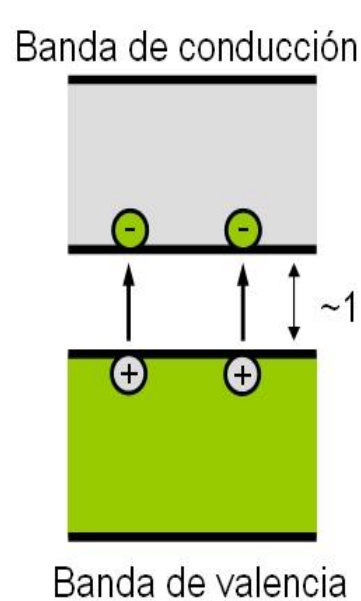
CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=202476>

# LED: Conexión en Directa

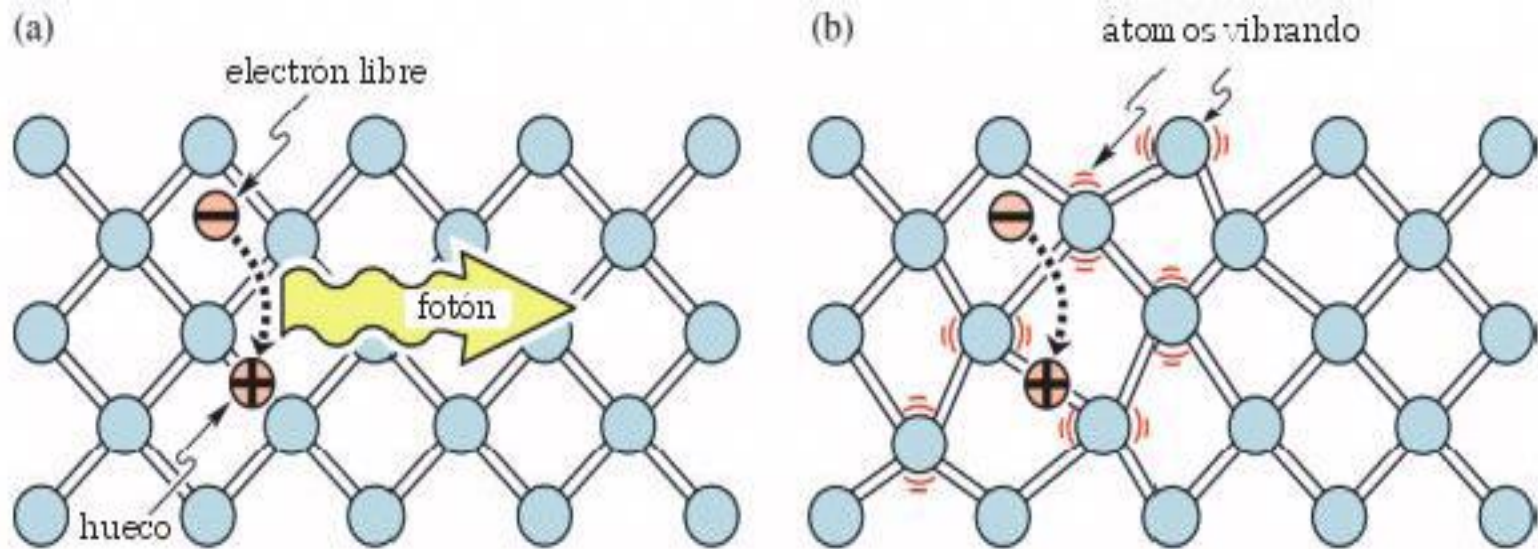


# Transición del Electrón

## En un Semiconductor

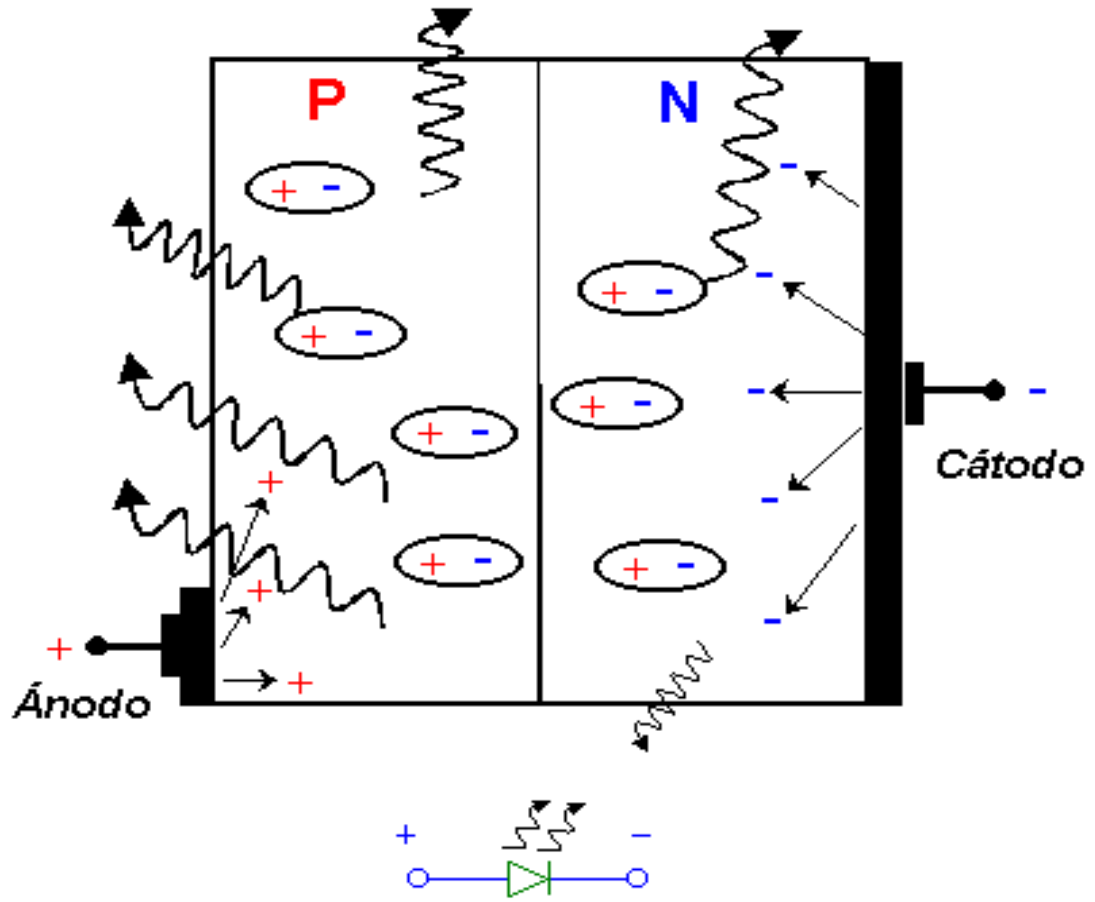


# Emisión de LUZ



La energía que se pierde en una unión PII, cuando tiene lugar una recombinación se transforma en dos tipos:  
a) liberación de fotones (ondas electromagnéticas) b) calor (agitación de átomos)

# LED: Emisión de LUZ



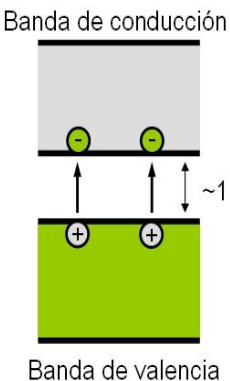
IIIa		IVa		Va		VIa		VIIa		4.22 0.93	31.8 1s
<b>5</b>	<b>B</b>	<b>6</b>	<b>C</b>	<b>7</b>	<b>N</b>	<b>8</b>	<b>O</b>	<b>9</b>	<b>F</b>	<b>10</b>	<b>Ne</b>
10,811		12,0107		14,00674		15,9994		18,998403		20,1797	
<b>Boro</b>		<b>Carbono</b>		<b>Nitrógeno</b>		<b>Oxígeno</b>		<b>Flúor</b>		<b>Neón</b>	
3	1.026	-4.2.4	0.710	-3.2.3.4.5	1.04	-2	0.92	-1	0.824	-	1.03
2.34	2.04	2.26	2.55	1.251	3.04	1.429	3.44	1.696	3.98	0.900	-
2365	801	4100	1087	63.15	1402	54.8	1314	53.48	1681	24.55	2081
4275	4.6	5100	4.6	77.35	17.3	90.18	14.0	84.95	17.1	27.1	16.7
0.82		0.77		0.75		0.73		0.72		0.71	
[He]2s <sup>2</sup> 2p <sup>1</sup>		[He]2s <sup>2</sup> 2p <sup>2</sup>		[He]2s <sup>2</sup> 2p <sup>3</sup>		[He]2s <sup>2</sup> 2p <sup>4</sup>		[He]2s <sup>2</sup> 2p <sup>5</sup>		[He]2s <sup>2</sup> 2p <sup>6</sup>	
<b>13</b>	<b>Al</b>	<b>14</b>	<b>Si</b>	<b>15</b>	<b>P</b>	<b>16</b>	<b>S</b>	<b>17</b>	<b>Cl</b>	<b>18</b>	<b>Ar</b>
26,981538		28,0855		30,973761		32,066		35,4527		39,948	
<b>Aluminio</b>		<b>Silicio</b>		<b>Fósforo</b>		<b>Azufre</b>		<b>Cloro</b>		<b>Argón</b>	
3	0.904	4	0.712	-3.3.4.5	0.770	-2.2.4.6	0.705	-1.1.3.5.7	0.478	-	0.52
2.70	1.61	2.33	1.9	1.82	2.19	2.07	2.58	3.214	3.16	1.784	-
933.5	578	1683	787	317.3	1012	388.4	1000	172.2	1251	83.8	-
2793	10.0	3540	12.1	550	17.0	717.8	15.5	239.1	18.7	87.3	1521
1.18		1.11		1.06		1.02		0.99		0.98	24.2
[Ne]3s <sup>2</sup> 3p <sup>1</sup>		[Ne]3s <sup>2</sup> 3p <sup>2</sup>		[Ne]3s <sup>2</sup> 3p <sup>3</sup>		[Ne]3s <sup>2</sup> 3p <sup>4</sup>		[Ne]3s <sup>2</sup> 3p <sup>5</sup>		[Ne]3s <sup>2</sup> 3p <sup>6</sup>	
<b>31</b>	<b>Ga</b>	<b>32</b>	<b>Ge</b>	<b>33</b>	<b>As</b>	<b>34</b>	<b>Se</b>	<b>35</b>	<b>Br</b>	<b>36</b>	<b>Kr</b>
69,723		72,61		74,92160		78,96		79,904		83,8	
<b>Galio</b>		<b>Germanio</b>		<b>Arsénico</b>		<b>Selenio</b>		<b>Bromo</b>		<b>Kriptón</b>	
3	0.371	4	0.322	-3.3.5	0.328	-2.4.6	0.321	-1.1.5	0.473	-	0.248
5.91	1.81	5.32	2.01	5.72	2.18	4.79	2.55	3.12	2.96	3.7	-
302.9	579	1211.5	762	1090 (36Atm)	947	494	941	265.9	1140	115.8	1351
2478	11.8	3107	13.6	886 (Sublim)	13.1	958	16.5	332.2	23.5	119.8	32.2
1.26		1.22		1.20		1.16		1.14		1.12	
[Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>1</sup>		[Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>2</sup>		[Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>3</sup>		[Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>4</sup>		[Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>5</sup>		[Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>6</sup>	
<b>48</b>	<b>In</b>	<b>50</b>	<b>Sn</b>	<b>51</b>	<b>Sb</b>	<b>52</b>	<b>Te</b>	<b>53</b>	<b>I</b>	<b>54</b>	<b>Xe</b>
114,818		118,71		121,760		127,60		126,90447		131,29	
<b>Indio</b>		<b>Estaño</b>		<b>Antimonio</b>		<b>Teluro</b>		<b>Yodo</b>		<b>Xenón</b>	
3	0.233	2.4	0.228	-3.3.5	0.207	-2.4.6	0.201	-1.1.5.7	0.214	-	0.158
7.31	1.78	7.31	1.96	6.69	2.05	6.24	2.1	4.93	2.66	5.9	2.6
429.8	558	505.1	709	904	834	722.7	869	386.7	1008	161.4	1170
2346	15.7	2876	16.3	1860	18.4	1261	20.5	458.4	25.7	165.1	42.9
1.44		1.41		1.40		1.36		1.33		1.31	
[Kr]4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>1</sup>		[Kr]4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>2</sup>		[Kr]4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>3</sup>		[Kr]4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>4</sup>		[Kr]4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>5</sup>		[Kr]4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>6</sup>	



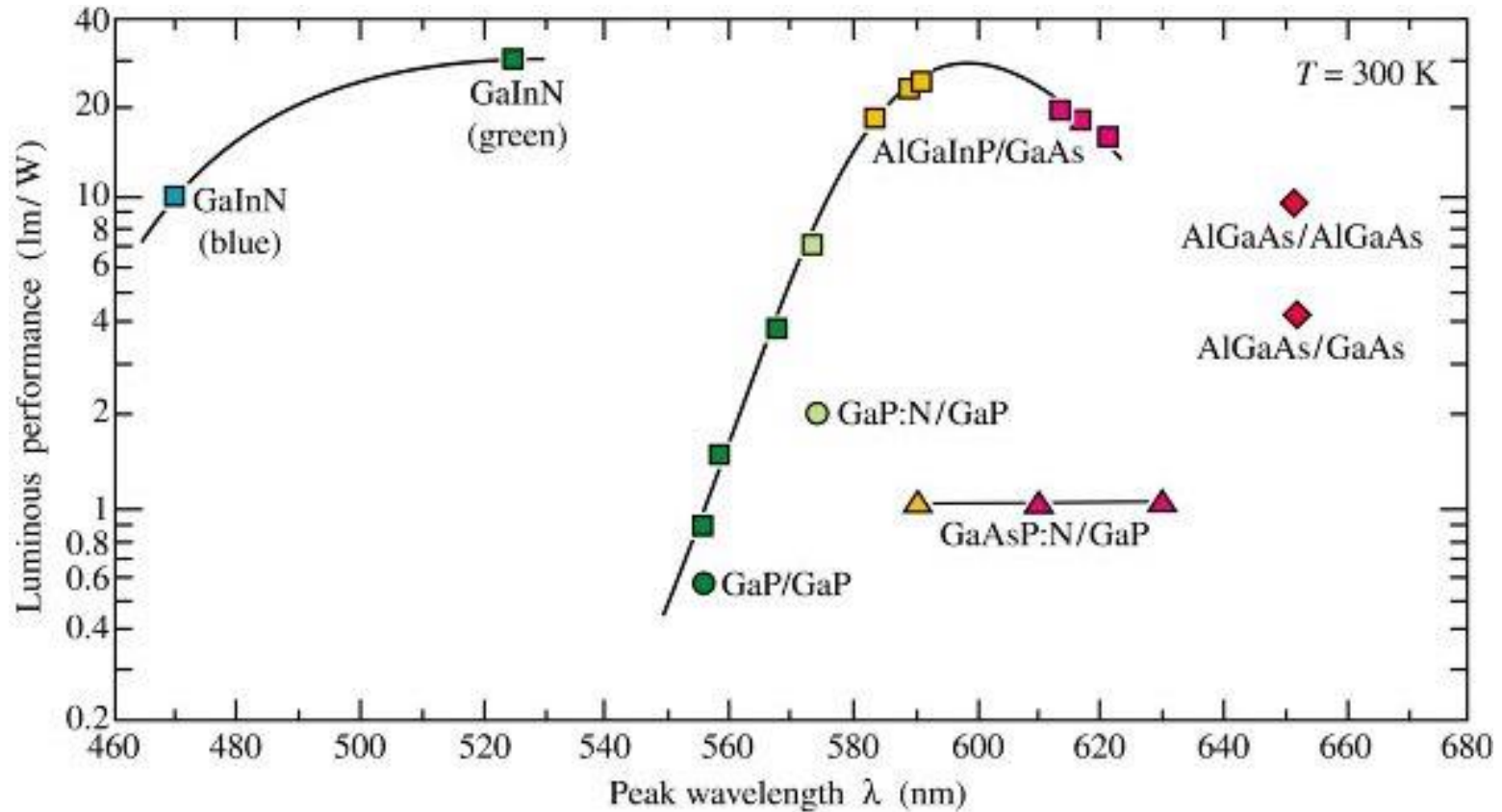
<b>13</b> 26,981538 <b>Al</b> <b>Aluminio</b> 3 2.70 933.5 2793 1.18 0.904 1.61 578 10.0 $[Ne]3s^23p^1$	<b>14</b> 28,0855 <b>Si</b> <b>Silicio</b> 4 2.33 1683 3540 1.11 0.712 1.9 787 12.1 $[Ne]3s^23p^2$	<b>15</b> 30,973761 <b>P</b> <b>Fósforo</b> -3.3,4.5 1.82 317.3 550 1.06 0.770 2.19 1012 17.0 $[Ne]3s^23p^3$
<b>31</b> 69,723 <b>Ga</b> <b>Galio</b> 3 5.91 302.9 2478 1.26 0.371 1.81 579 11.8 $[Ar]3d^{10}4s^24p^1$	<b>32</b> 72,61 <b>Ge</b> <b>Germanio</b> 4 5.32 1211.5 3107 1.22 0.322 2.01 762 13.6 $[Ar]3d^{10}4s^24p^2$	<b>33</b> 74,92160 <b>As</b> <b>Arsénico</b> -3.3.5 5.72 1090 (36Atm) 886 (Sublim) 1.20 0.328 2.18 947 13.1 $[Ar]3d^{10}4s^24p^3$
<b>49</b> 114,818 <b>In</b> <b>Indio</b> 3 7.31 429.8 2346 1.44 0.233 1.78 558 15.7 $[Kr]4d^{10}5s^25p^1$	<b>50</b> 118,71 <b>Sn</b> <b>Estaño</b> 2.4 7.31 505.1 2876 1.41 0.228 1.96 709 16.3 $[Kr]4d^{10}5s^25p^2$	<b>51</b> 121,760 <b>Sb</b> <b>Antimonio</b> -3.3.5 6.69 904 1860 1.40 0.207 2.05 834 18.4 $[Kr]4d^{10}5s^25p^3$

# Compuestos Empleados en la Construcción de los LED

Compuesto	Color	Long. de onda
arseniuro de galio (GaAs)	Infrarrojo	940 nm
arseniuro de galio y aluminio (AlGaAs)	rojo e infrarrojo	890 nm
arseniuro fosfuro de galio (GaAsP)	rojo, anaranjado y amarillo	630 nm
fosfuro de galio (GaP)	verde	555 nm
nitruro de galio (GaN)	verde	525 nm
seleniuro de cinc (ZnSe)	azul	
nitruro de galio e indio (InGaN)	azul	450 nm
carburo de silicio (SiC)	azul	480 nm
diamante (C)	ultravioleta	
silicio (Si)	en desarrollo	

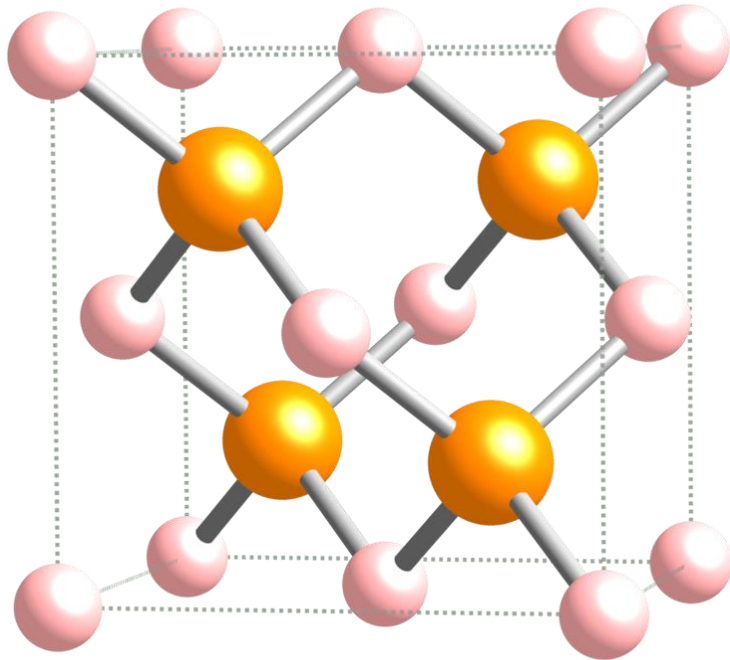


# Materiales del LED

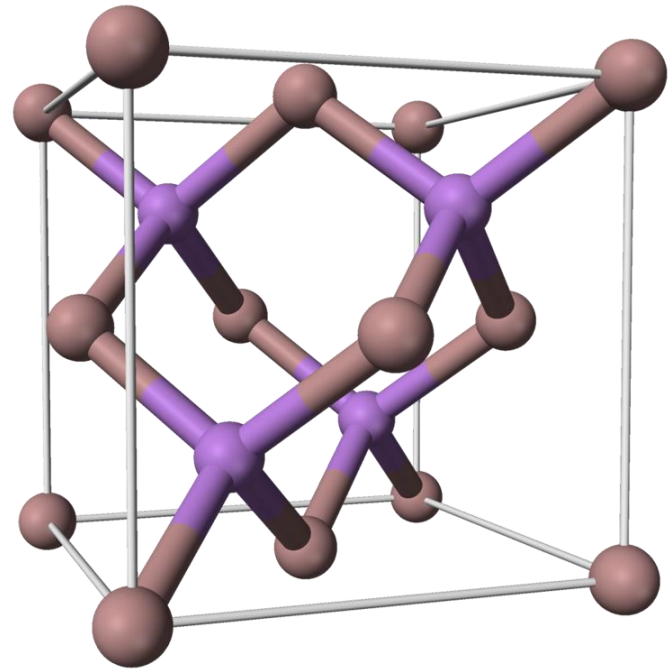


# Materiales del LED

## ARSENIURO DE ALUMINIO



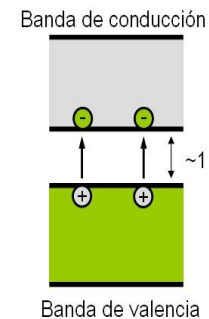
## ARSENIURO DE GALIO



# TENSION de los LED

## Según su Color

LONGITUD DE ONDA [nm]		TENSION [V]
565	VERDE	2,2 - 3,0
590	AMARILLO	2,2 - 3,0
615	NARANJA	1,8 - 2,7
640	ROJO	1,6 - 2,0
690	ROJO	2,2 - 3,0
880	INFRARROJO	2,0 - 2,5
900	INFRARROJO	1,2 - 1,6
940	INFRARROJO	1,3 - 1,7

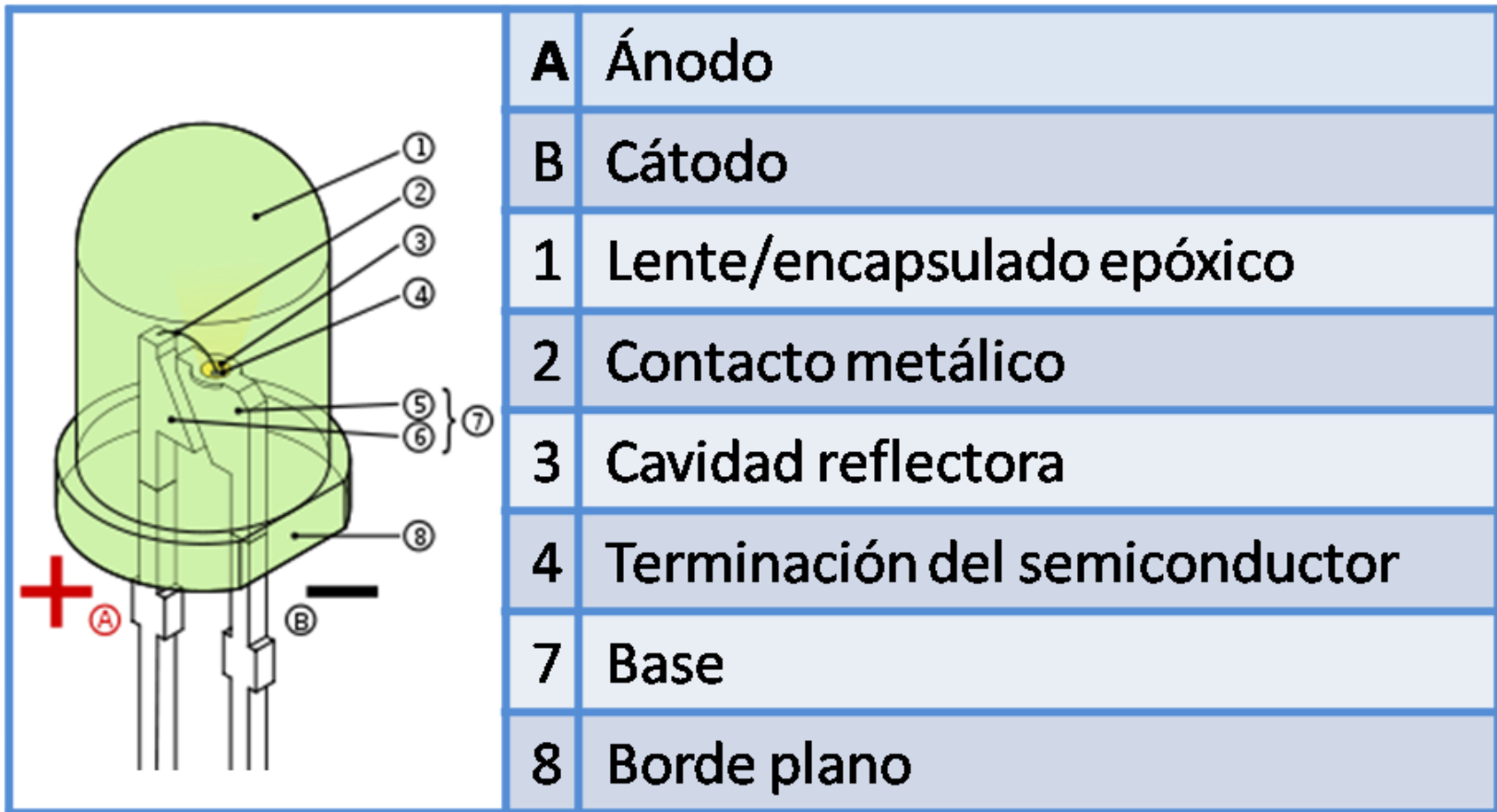


# TENSION de los LED

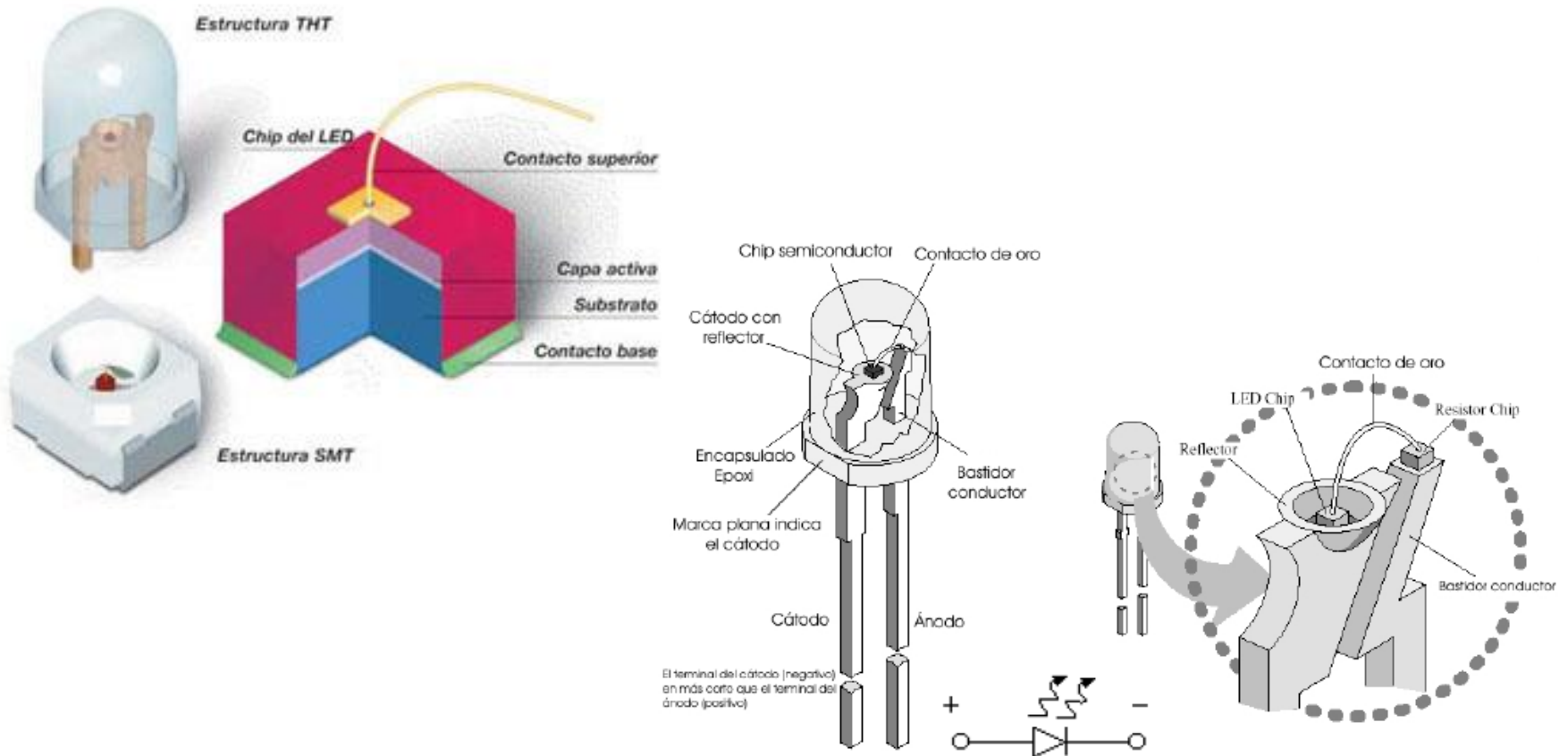
Según su Color (Otros colores)

Color	Long. de onda (nm)	Voltaje (V)
Infrarrojo	$\lambda > 760$	$\Delta V < 1,63$
Rojo	$610 < \lambda < 760$	$1,63 < \Delta V < 2,03$
Naranja	$590 < \lambda < 610$	$2,03 < \Delta V < 2,10$
Amarillo	$570 < \lambda < 590$	$2,10 < \Delta V < 2,18$
Verde	$500 < \lambda < 570$	$1,90 < \Delta V < 4,00$
Azul	$450 < \lambda < 500$	$2,48 < \Delta V < 3,70$
Violeta	$400 < \lambda < 450$	$2,76 < \Delta V < 4,00$
Morado	Varios tipos	$2,48 < \Delta V < 3,70$
Ultravioleta	$\lambda < 400$	$3,10 < \Delta V < 4,40$
Rosa	Varios tipos	$\Delta V$ aprox. 3,3
Blanco	Todo el espectro	$\Delta V$ aprox. 3,5

# LED



# LED: Conexión Interna

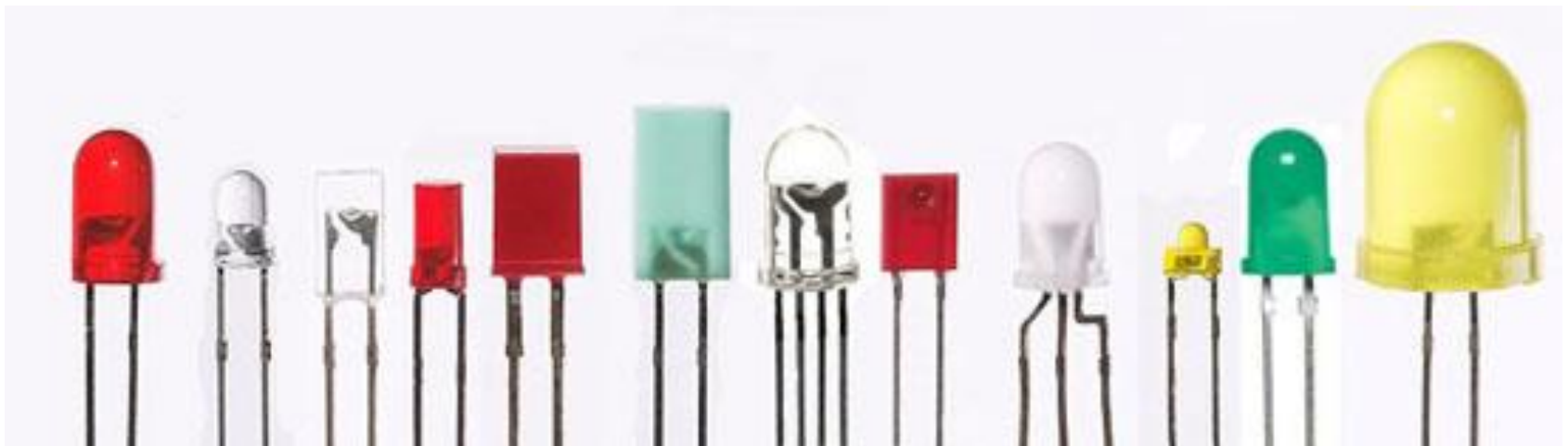




# Tipos de LED



**Fig 1.1: Distintos tipos de LED**





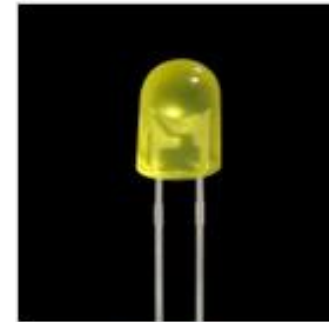
Degradation Resistant Blue



Subminiature LED



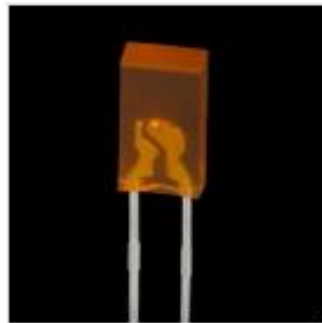
Round LED



Oval LED



Flat Top LED



Rectangular LED



Cylindrical LED



Multi-Color LED



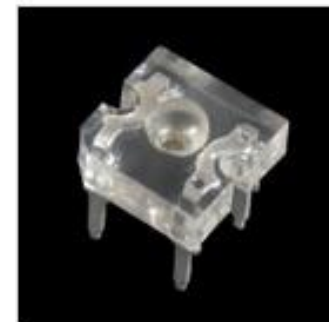
Resistor LED



Low Current LED



Blinking LED



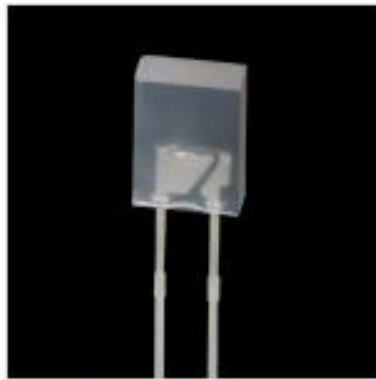
Super Flux LED

# Tipos de LED

<http://www.kingbright.com/>



Cylindrical Bi-Color



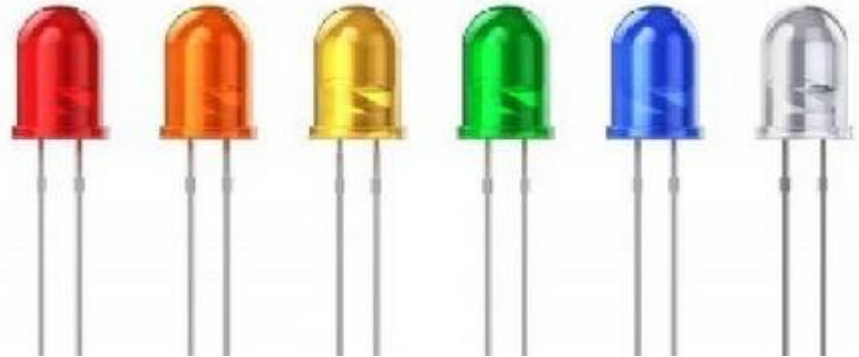
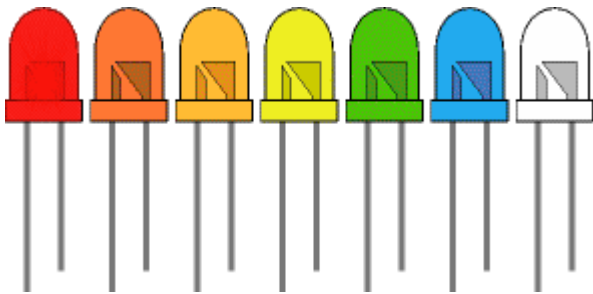
Rectangular Bi-Color



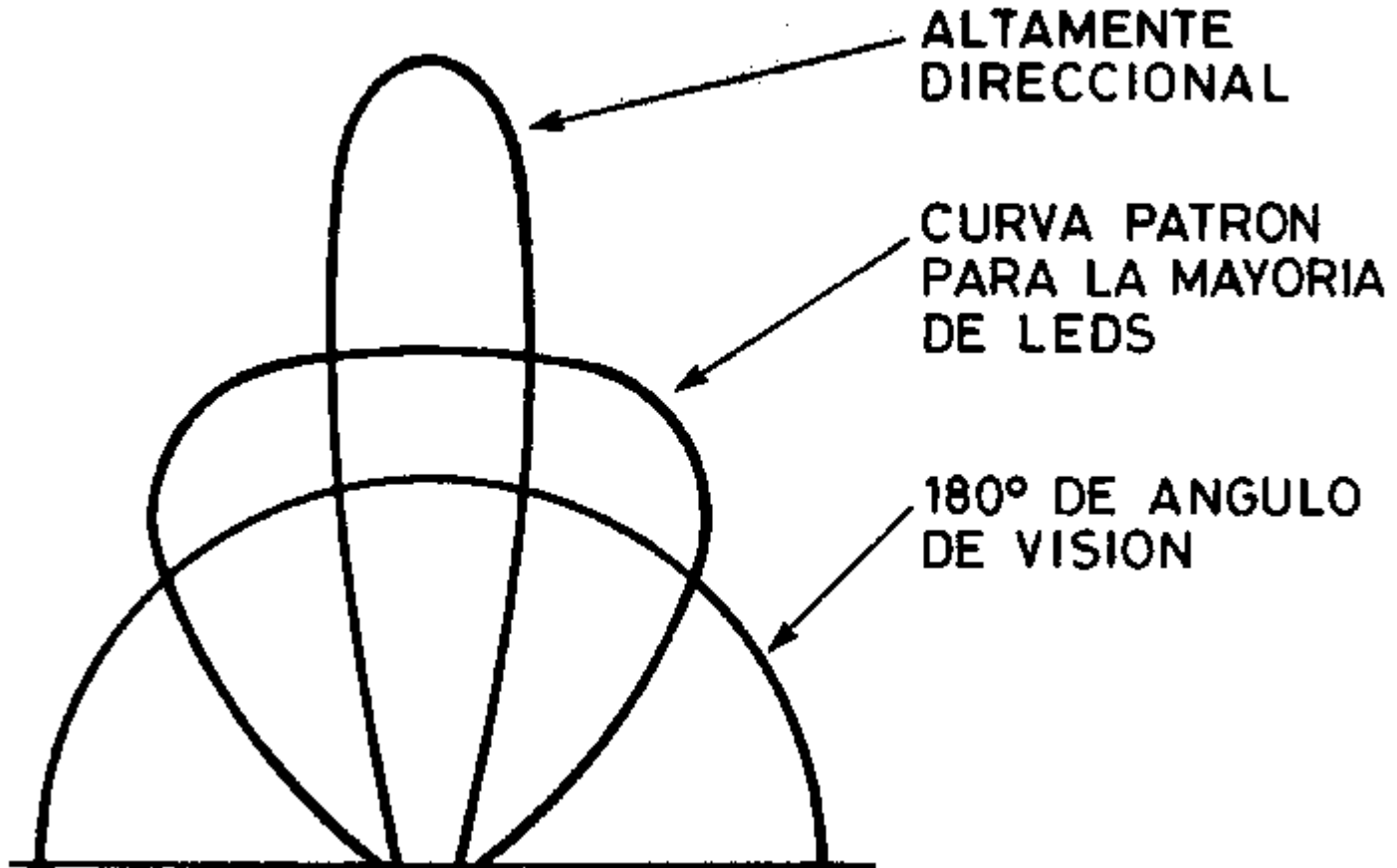
Round Bi-Color



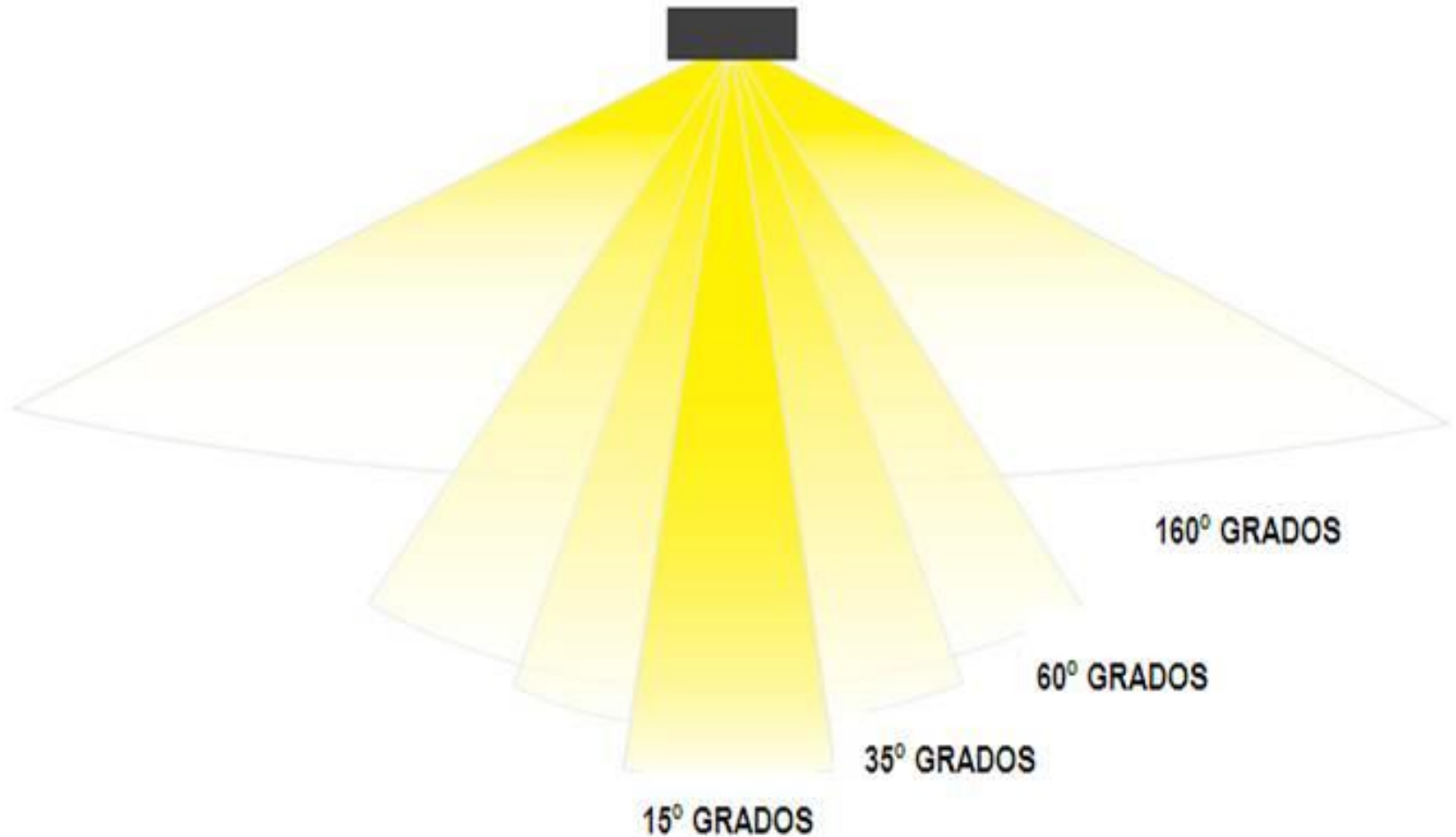
Round Full Color



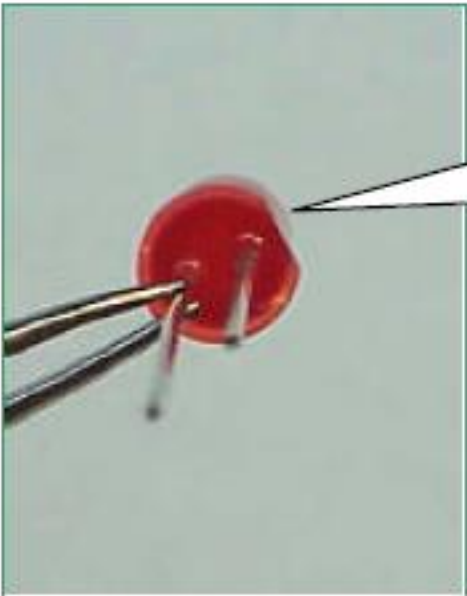
# Angulo de Irradiación



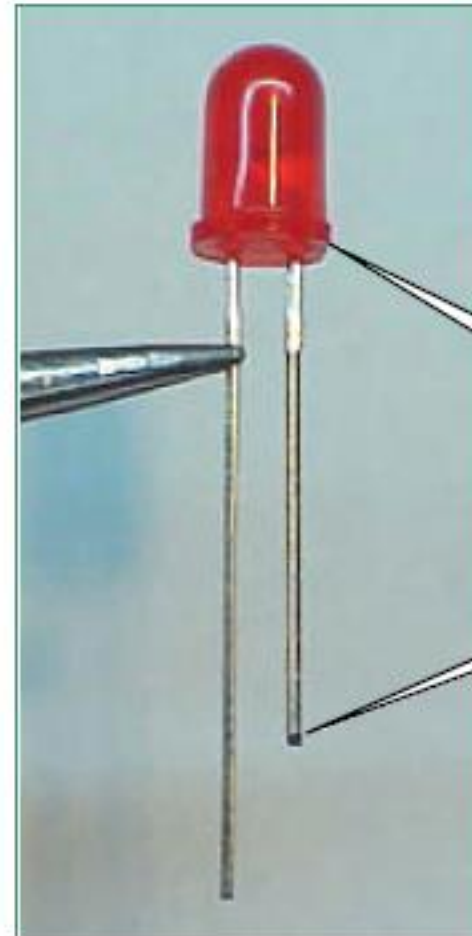
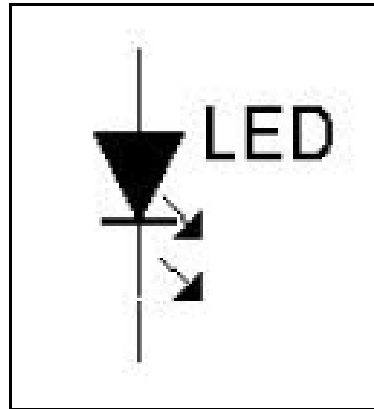
# Angulo de Irradiación



# IDENTIFICACION DE TERMINALES

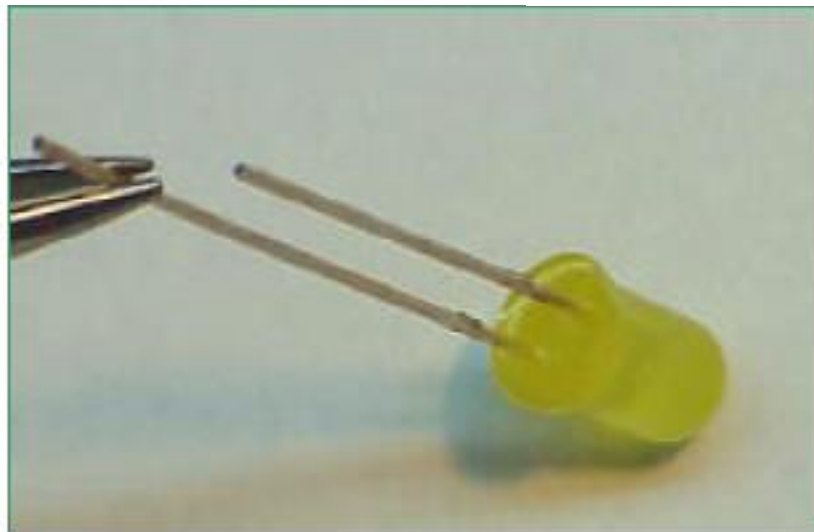


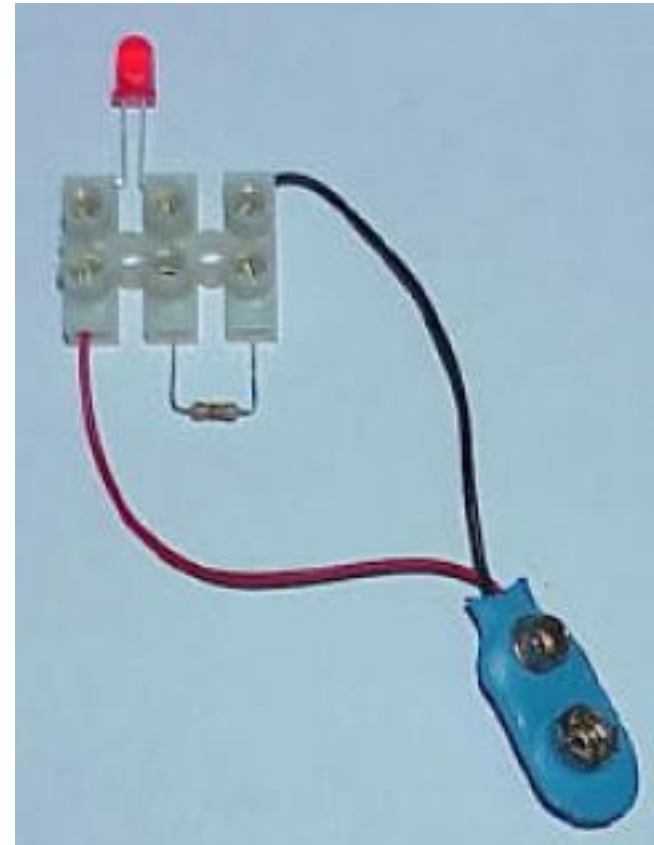
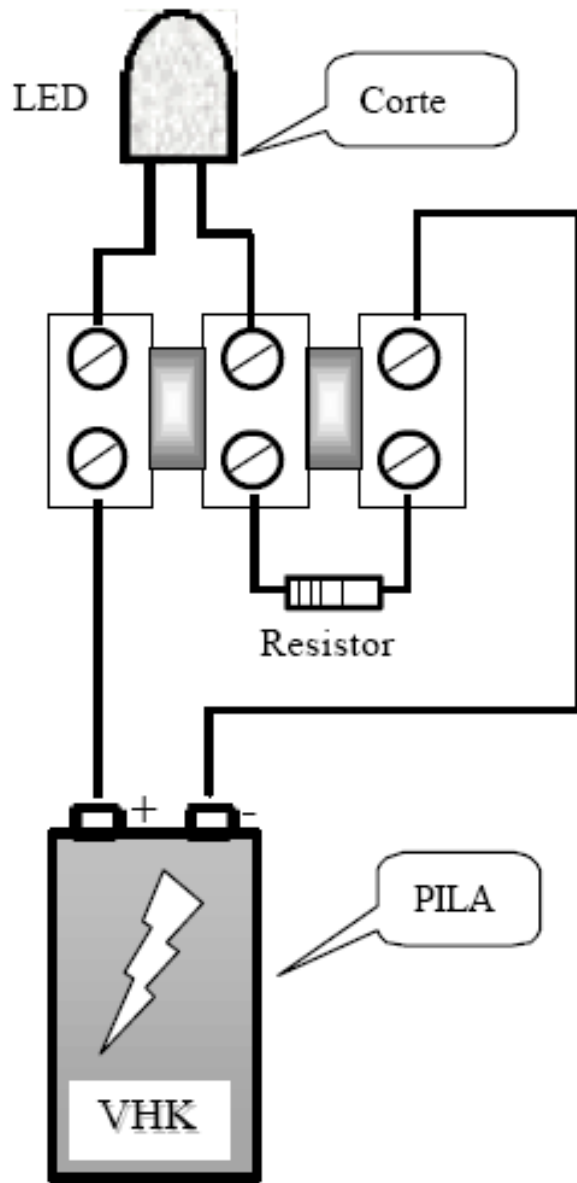
Corte que indica el cátodo



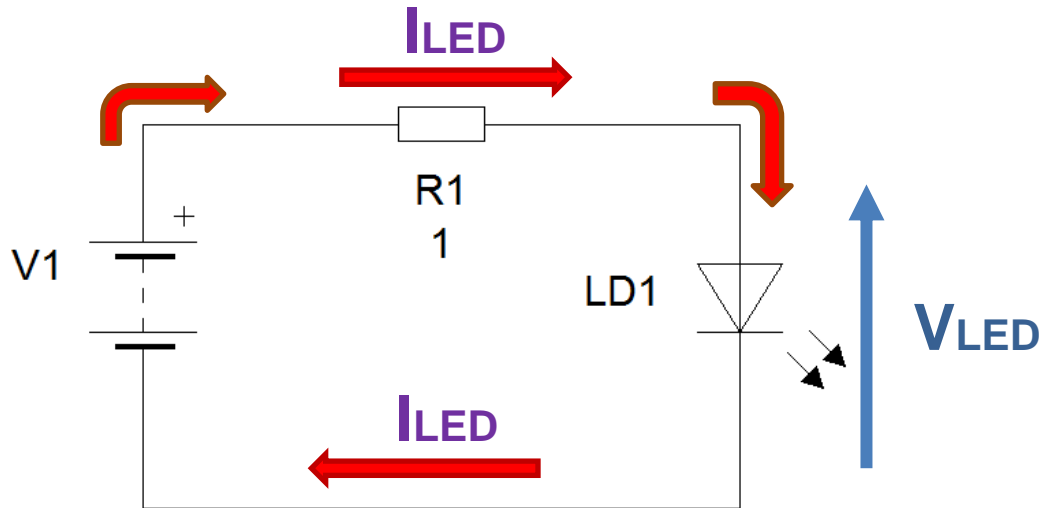
Corte

Cátodo



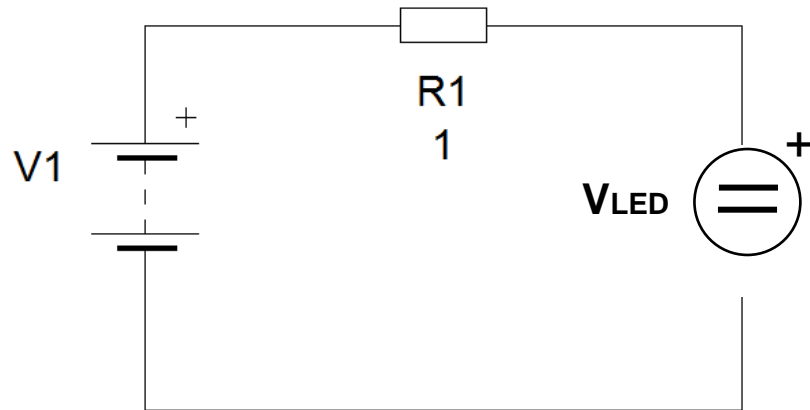


# Como Conectar un LED



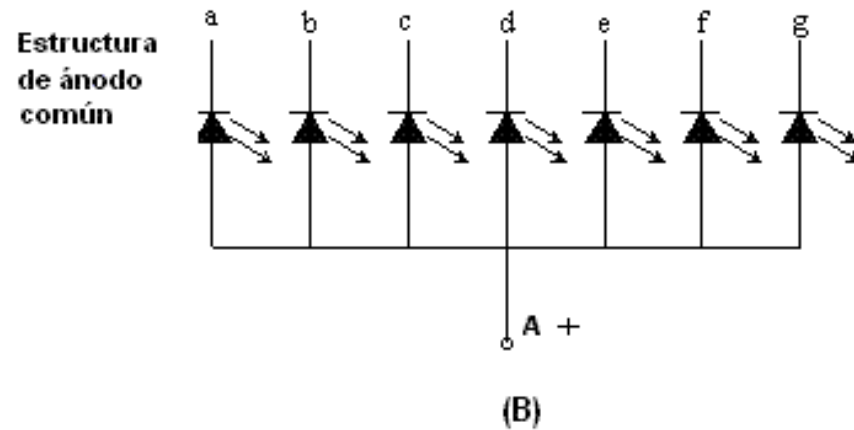
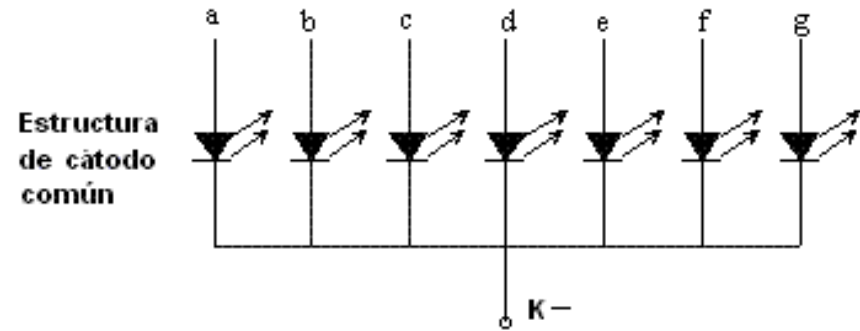
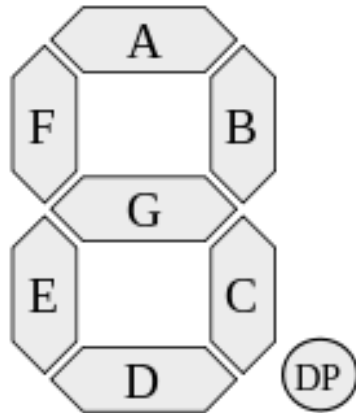
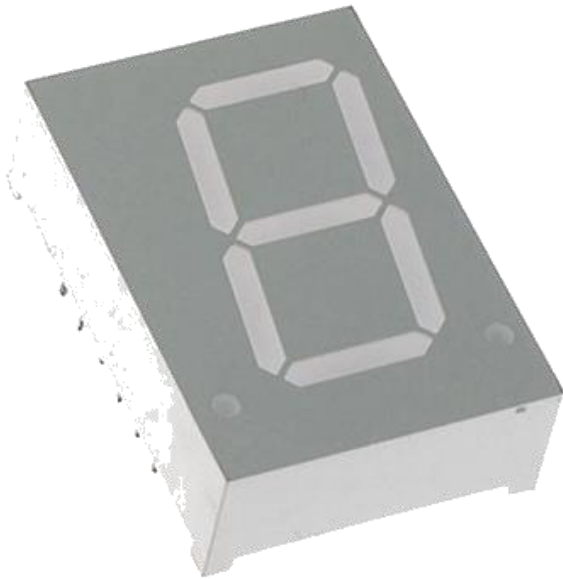
$$R_1 = \frac{V_1 - V_{LED}}{I_{LED}}$$

$V_{led} = 2 \text{ Vdc}$   
 $I_{led} = 20 \text{ mA}$

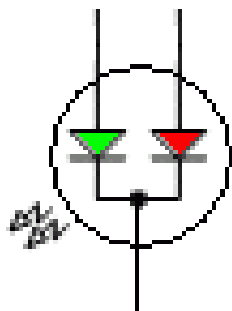




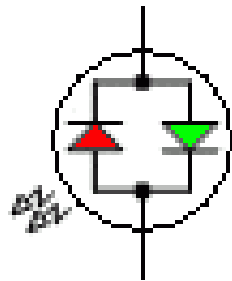
# Display 7 Segmentos



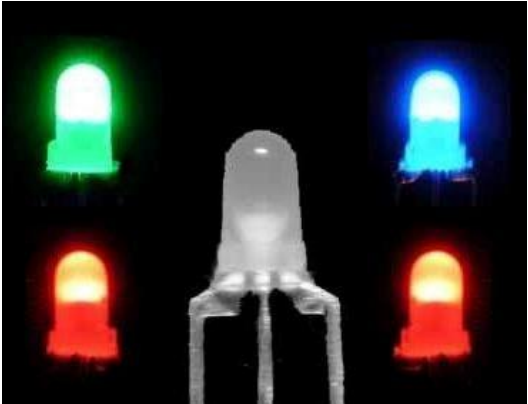
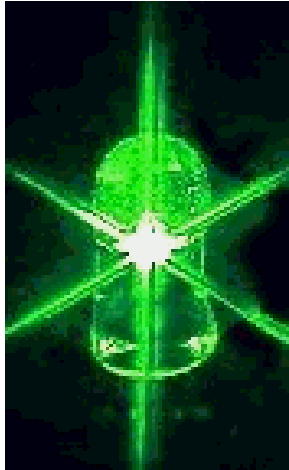
# LED Bicolor



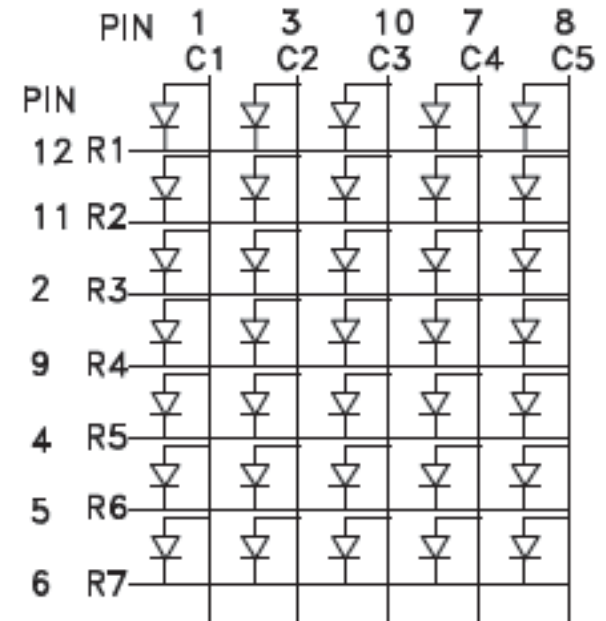
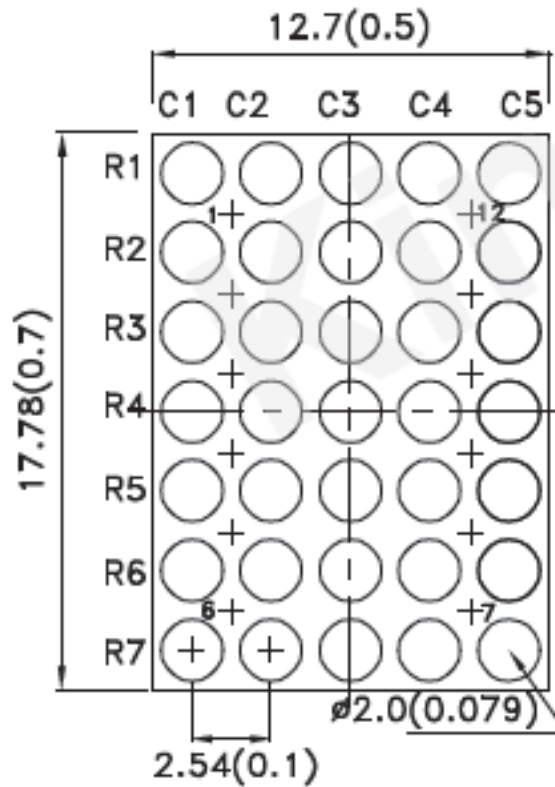
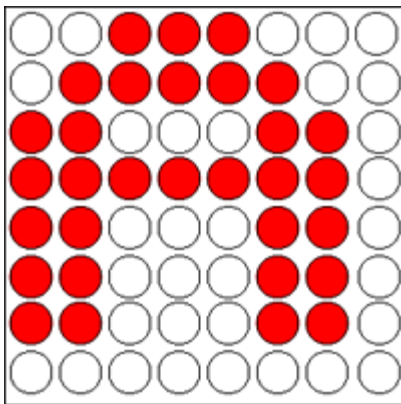
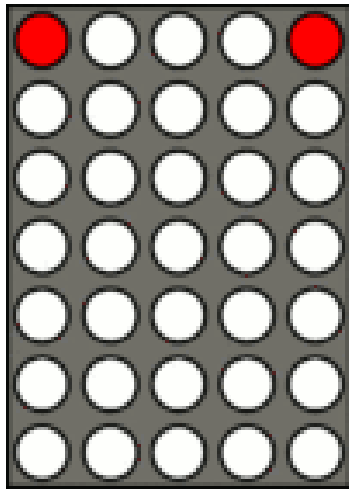
**bicolor  
catodo comum**



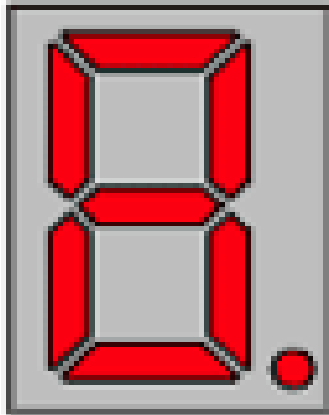
**bicolor  
bipolar**



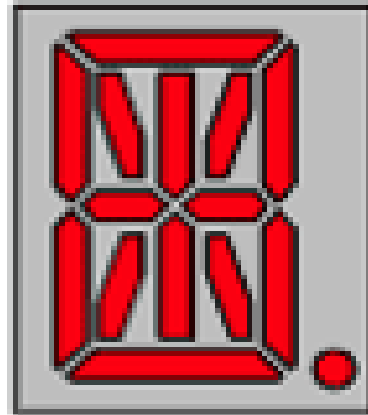
# MATRICES DE LED



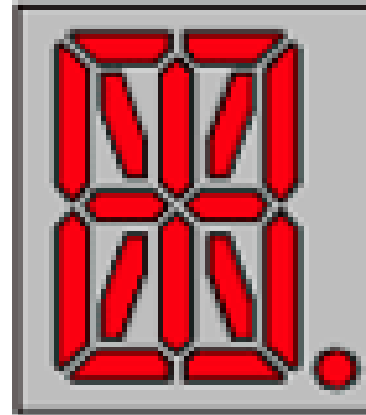
# Display Alfanuméricos



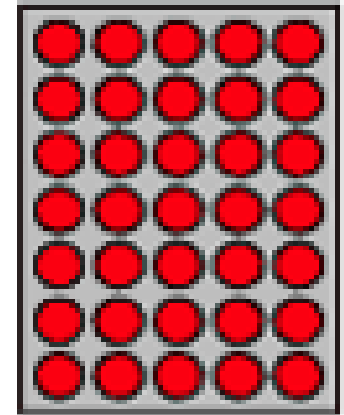
7-Segment  
plus DP



14-Segment  
plus DP



16-Segment  
plus DP

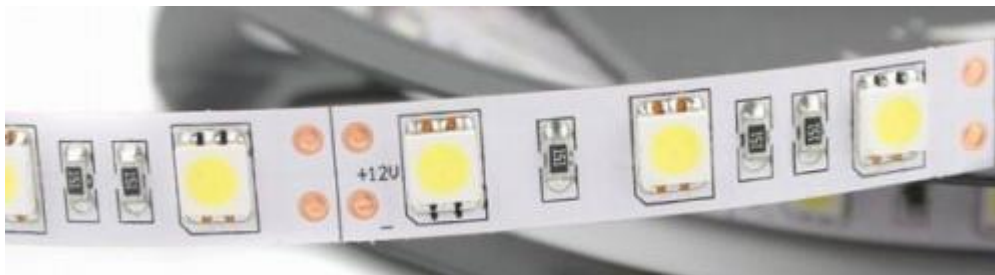
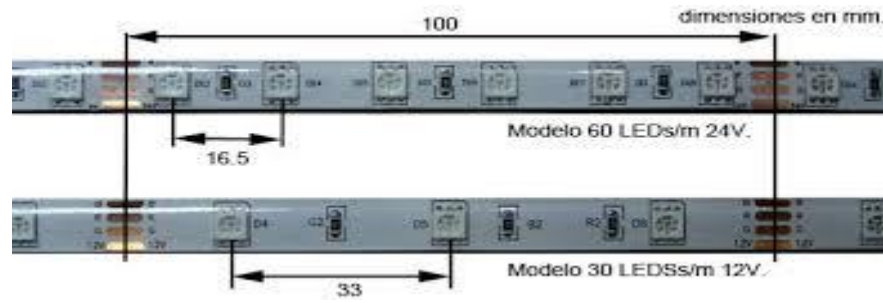
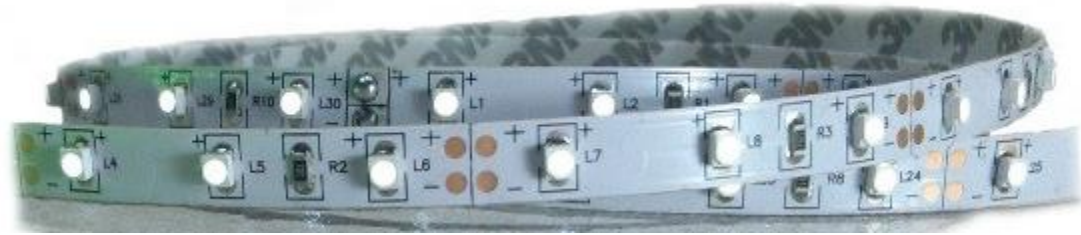


5 x 7 Matrix

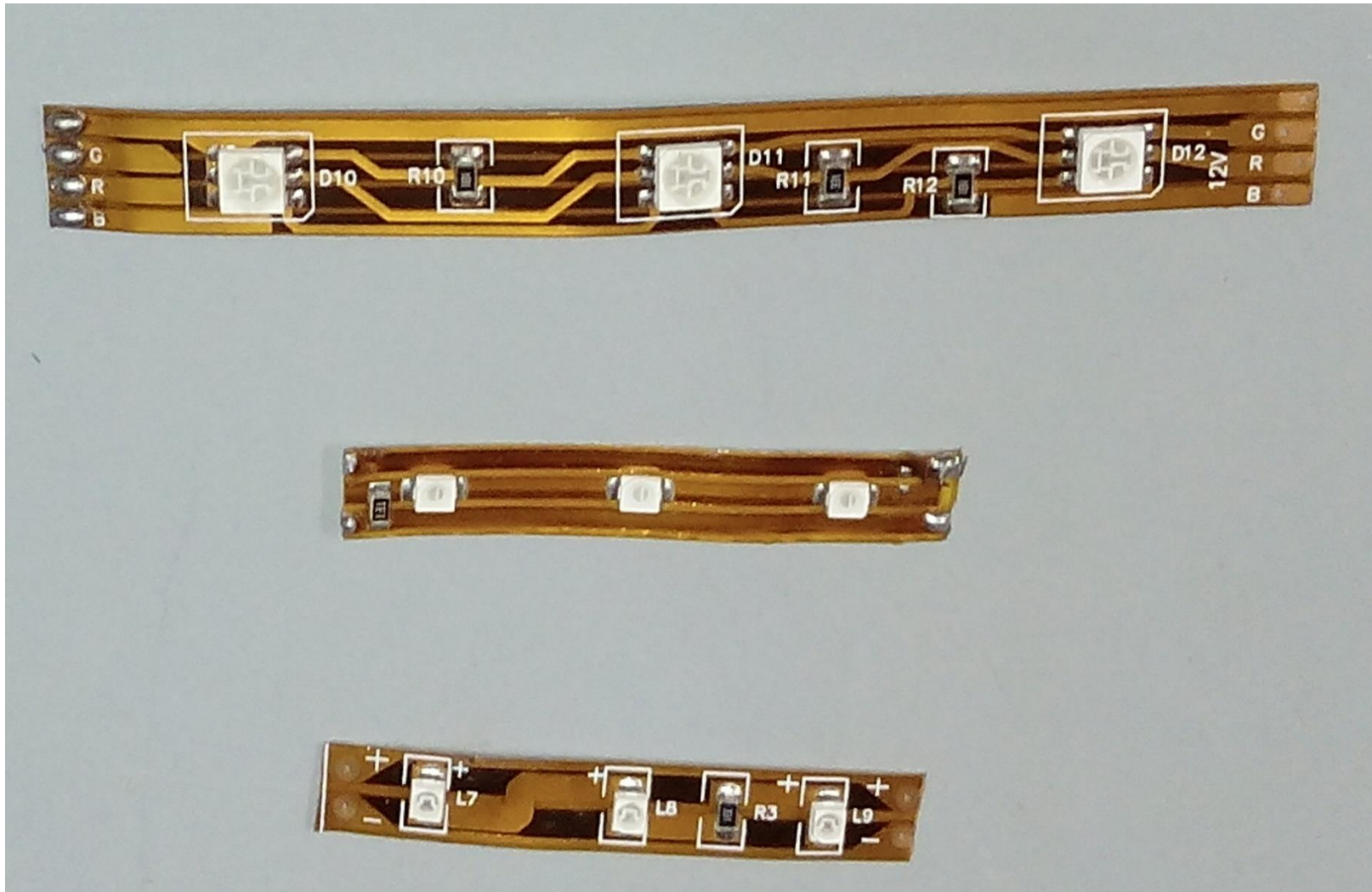
# CINTA DE LED



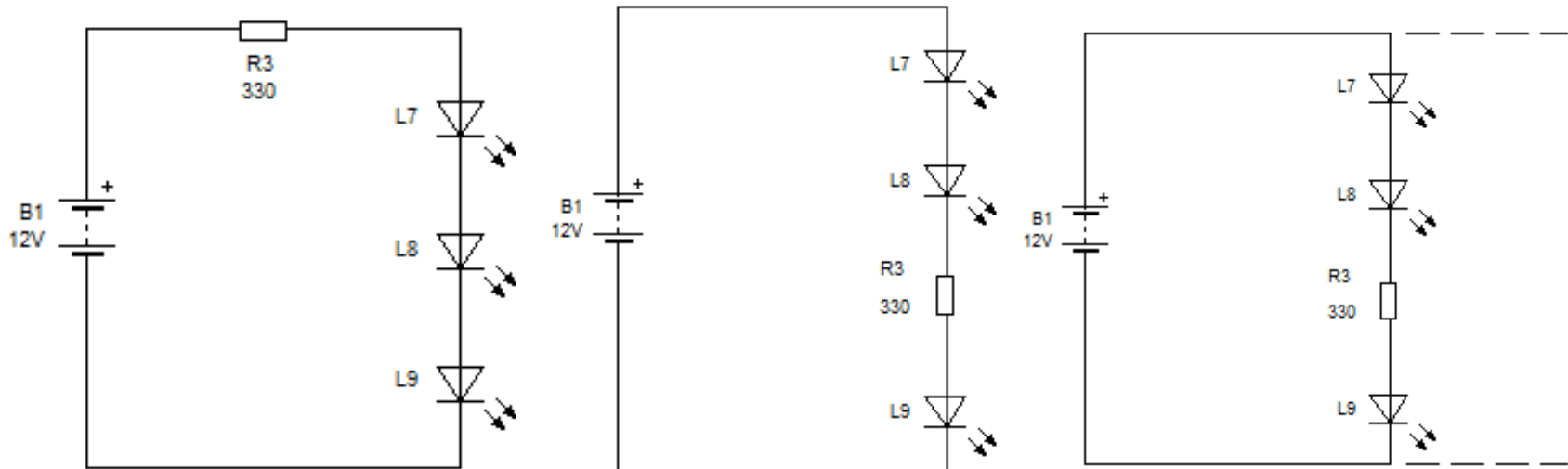
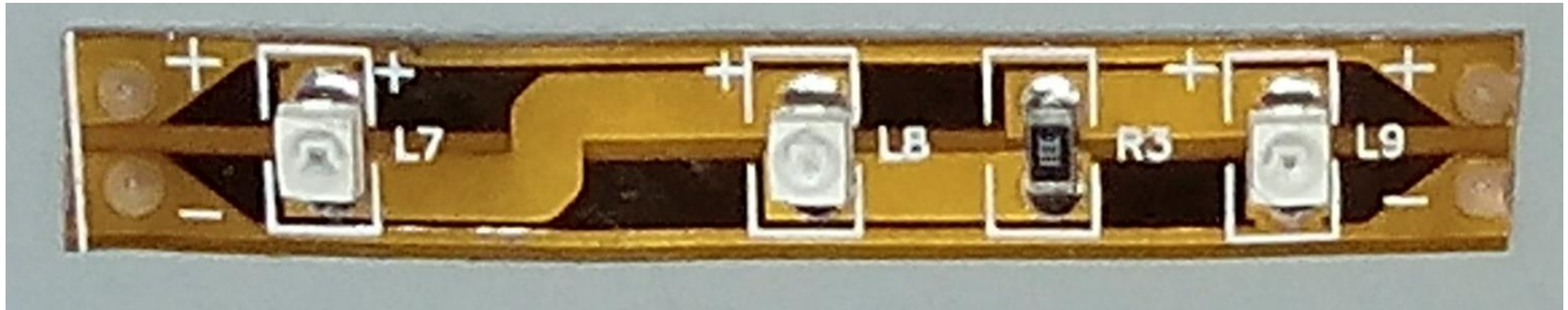
# CINTA DE LED



# CINTA DE LED

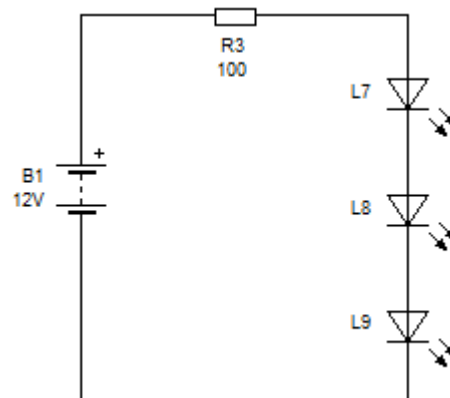
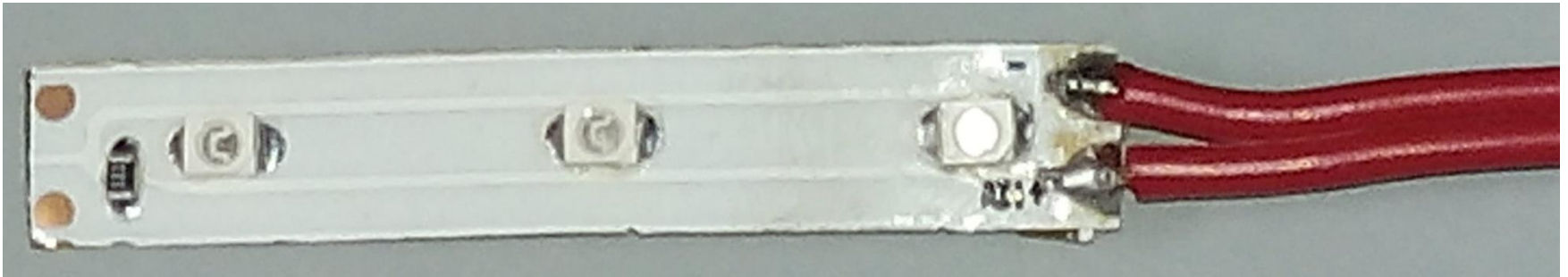


# CINTA DE LED

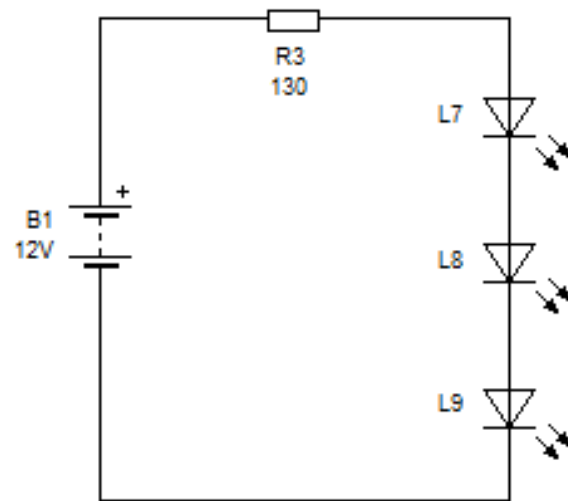
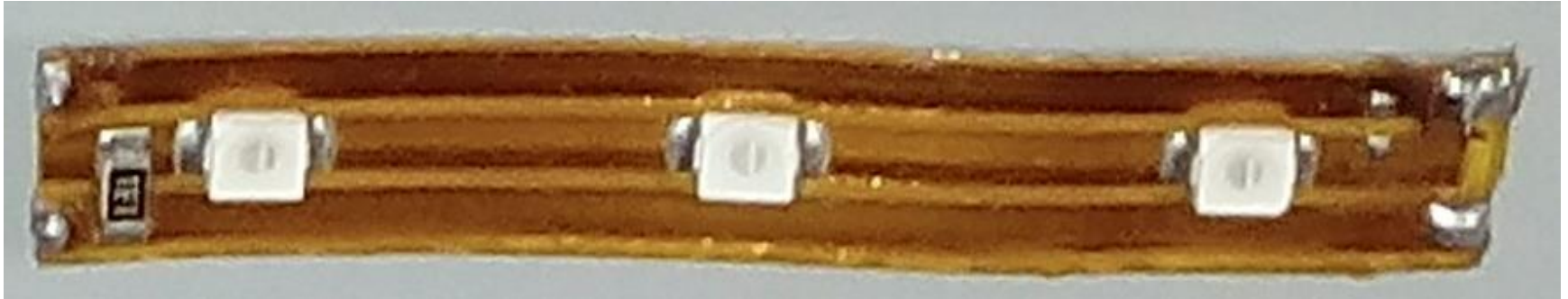




# CINTA DE LED

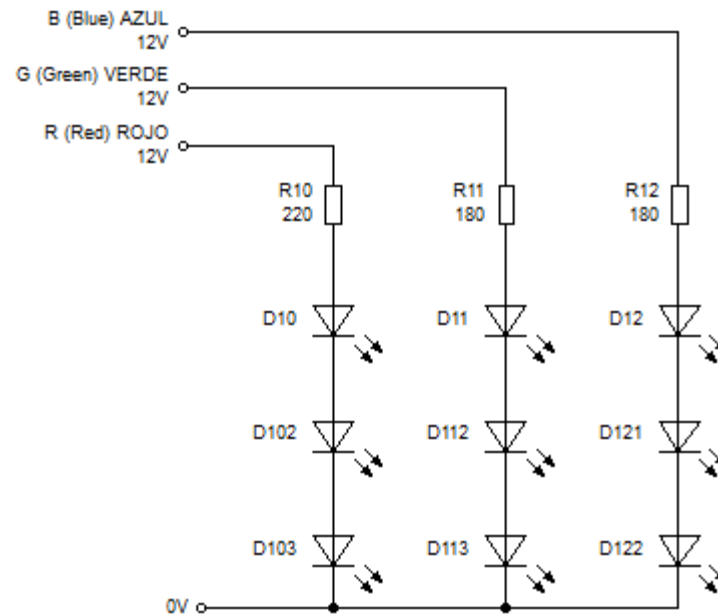
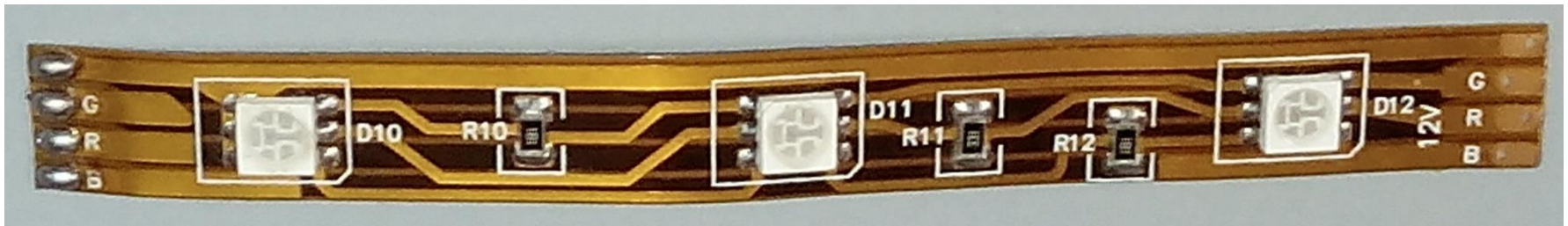


# CINTA DE LED

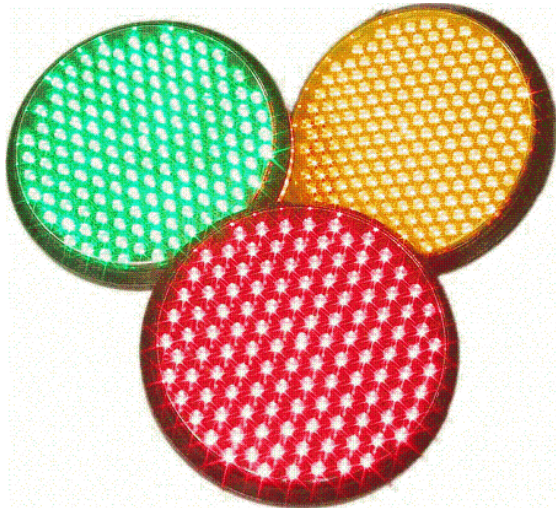


# CINTA DE LED

## Tipo RGB



# LED Otras Presentaciones



# FIN

