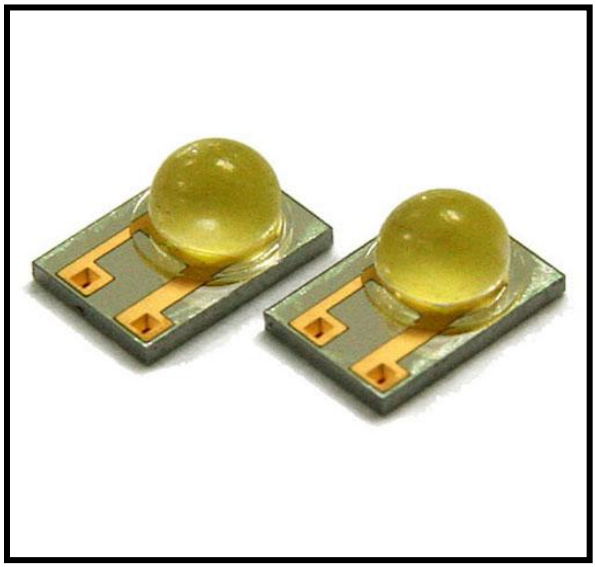
LED Submounts

OnChip Devices Offers Silicon and Ceramic Carriers or Submounts that greatly improve the performance of High Brightness Light Emitting Diodes



Introduction

High brightness LEDs are predominantly built with Indium Gallium Nitride (InGaN) technology. LEDs using InGaN come with several design challenges such as electrostatic discharge (ESD) sensitivity and package thermal coefficient of expansion (TCE) issues. InGaN chips are generally considered Class 1 devices and in many cases, a discharge of only 10 Volts can destroy such sensitive components. In comparison, static charge of up to 30,000 Volts is not uncommon and can be generated quite easily. Studies indicate that ESD damage to electronics and associated equipment is estimated at over $10 billion annually. ESD-damaged LEDs can appear dim, dead, shorted, or have low Vf or Vr. TCE mismatch between the LED chip and the lead-frame or package is another significant reliability threat.

LED Submounts and Chip Carriers

OnChip produces silicon and ceramic submount that serves as an inter-poser between the InGaN chip and the lead-frame. Submounts reduce the TCE mismatch, while providing ESD protection via integrated Zener diodes. Ceramics are ideal for High Power LEDs and OnChip offers both Aluminum Oxide and Aluminum Nitride materials. The Company also provides miniature silicon ESD diodes that can be mounted alongside the LED chips. These ESD diodes are available both as flip chips - ESD0201 and as single-wire bond chips - ESD8x8. Submounts offer optical benefits as well. These devices contain solder bumps, enabling flip chip assembly of the LED chip. This approach eliminates shadows caused by wire-bonding. Furthermore, submounts offer a reflective metal surface which help direct the light in the desired direction.

Thermal Advantages

The typical efficiency of high brightness LEDs varies from 10% to 40%. The remaining power is dissipated as heat within the LED die. Placing LEDs into a submount provides controlled heat management, allowing the substrate to transfer heat away from the die, lowering its junction temperature and increasing the life and reliability of the product. Table 1 shows the thermal conductivity of different ceramics used in LED submounts.

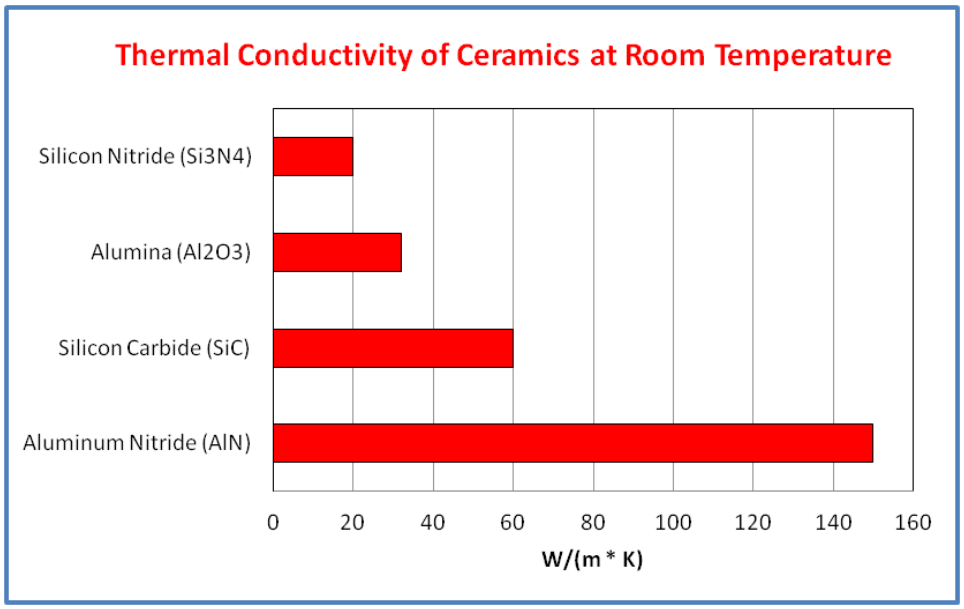


Table 1: Heat dissipation can be controlled by using different materials

Submount Structure

OnChip offers Single Die or Multi-Die LED packages for various applications. The structure allows heat transfer to occur at 4 different points throughout the submount, reducing heat along the way. Figure 1 shows the heat path from the light source to ambient air.

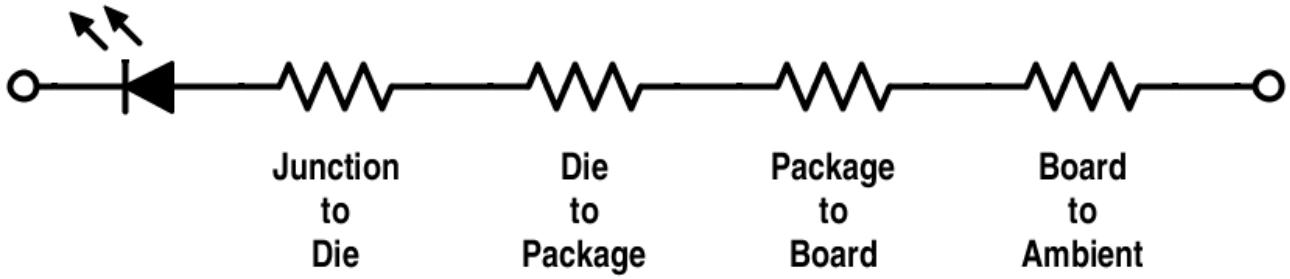


Figure 1: The path of heat dissipation.

OnChip's single die LED submount uses layers of different materials to efficiently reduce heat stress on the LED. Figure 2 shows the structure of a typical silicon submount for horizontal LEDs.

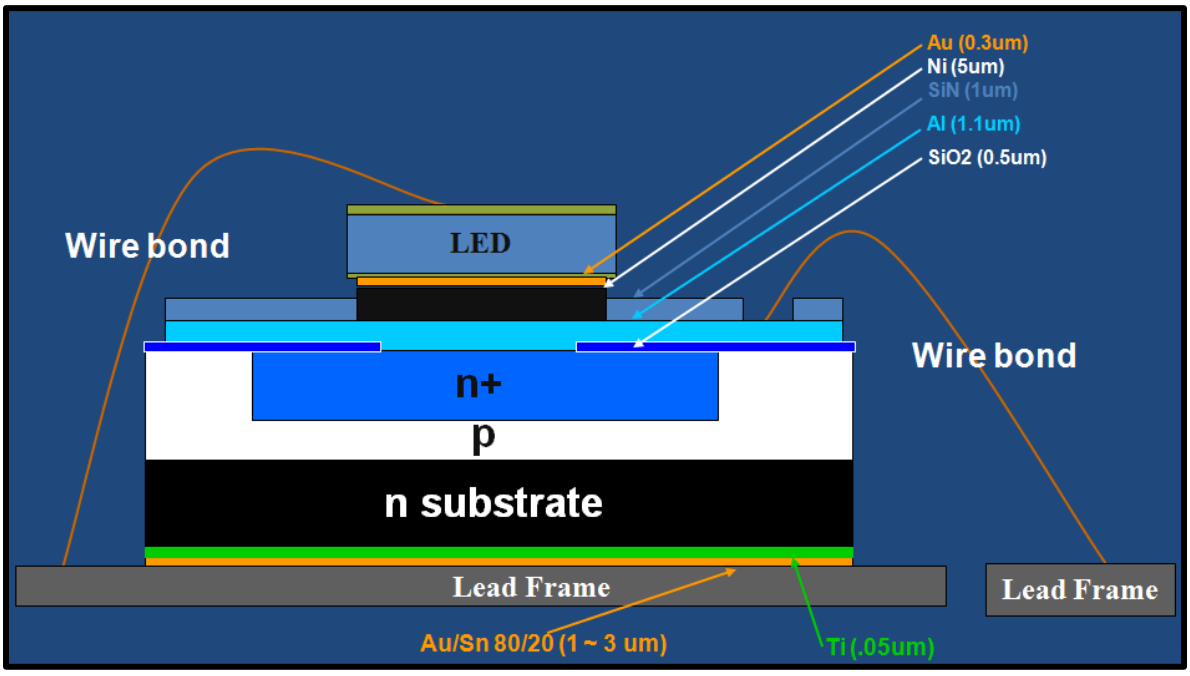


Figure 2: Silicon Submount for Horizontal LEDs

Ceramic submounts utilized filled vias to allow electrical conductivity from top metal to back metal. By surrounding the ceramic substrate with a via, surface area of the ceramic is utilized for better thermal dissipation. Figure 3 shows the structure of a ceramic submount.

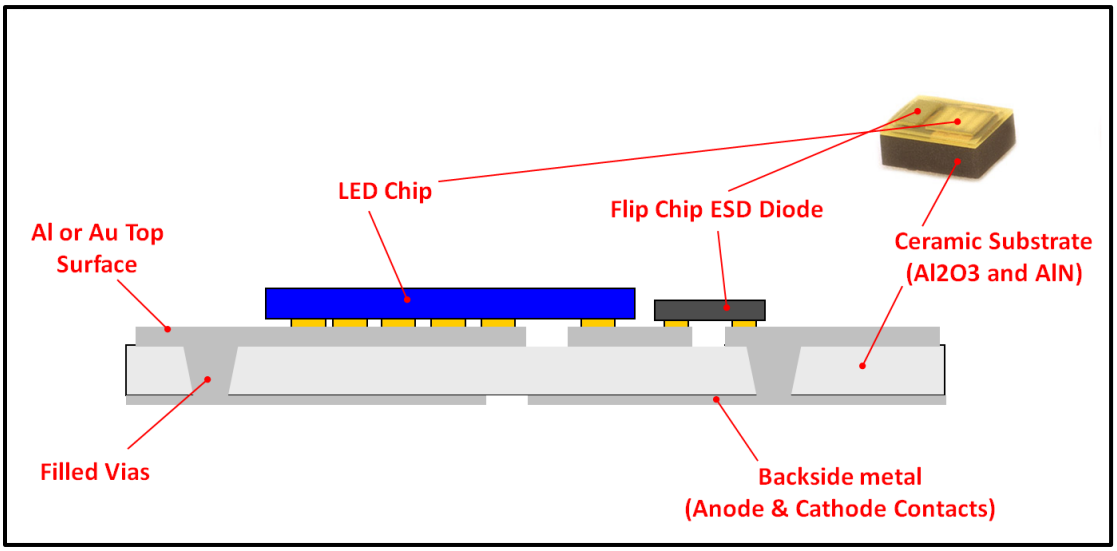
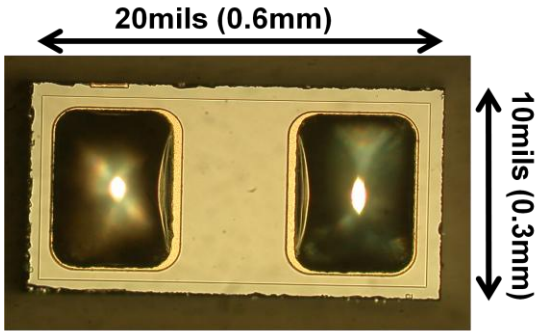


Figure 3: Ceramic Submount for Horizontal LEDs

Recommended Diodes for LED Submounts

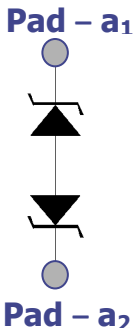
ESD0201

The ESD0201 is a back to back Zener diode configuration in an 0201 flip chip. It is 20x10x10 mils in size.



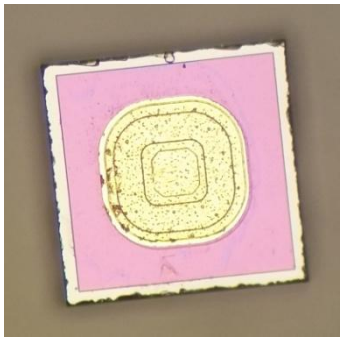
Full Ordering Part Number	
Solder Pad Material (RoHS Compliant)	**OnChip P/N**
Sn/Ag4/Cu0.5	ESD0201-01FR
5um electroless Ni/Au bumps	ESD0201-01FR-Au

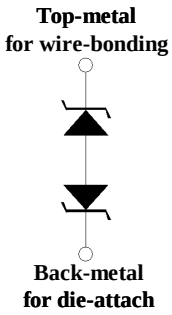
Electrical Specifications	Min.	Typ.	Max.	Unit
Leakage current at V=4V, 25°C	-	0.1	1	uA
Signal Clamp Voltage at 25°C @ 10mA	8	10	12	V
ESD Voltage "Contact" Discharge per IEC61000-4-2 Standards	± 30	-	-	kV
Clamping voltage during ESD discharge per IEC61000-4-2 at +/-30kV	-	+/-10	-	V
Input Capacitance	15	17.5	20	pF
Temperature Range: Operating Storage	 -40 -65	-	 150 150	°C



ESD-8x8

The ESD-8x8 is a wire bondable die with a low clamping voltage for small LED strings. It comes in an 8x8 mil die with the option for 4, 6, or 8 mil thickness. Top metal is Al (Au optional) and back metal is Au, Ag, or AuSn. Choose from several clamping voltages such as 5V, 12V, 24V and 30V.



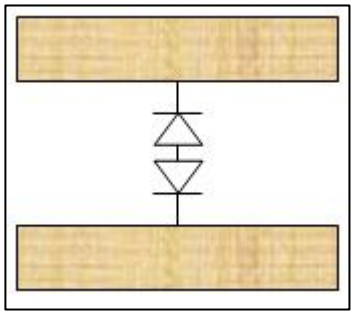


Electrical Specifications @ 25°C	Min.	Typ.	Max.	Unit
Leakage current at V=5V		<1		µA
Signal Clamp Voltage: Positive Clamp, 10mA Negative Clamp, 10mA	 5 -5	 7 -7	 15 -15	 V V
ESD withstand voltage*: Human Body Model (MIL-STD-883, method 3015)	 ± 8			 kV
ESD withstand voltage*: Contact Discharge Method (IEC 61000-4-2)	 ± 2	 ± 4		 kV
Clamping voltage during ESD discharge* Positive MIL-STD-883 (Method 3015), 4kV Negative		+15 -15		V
Diode Input Capacitance @ 0V *		3		pF
Temperature Range: Operating Storage	 -40 -65		 150 150	 °C

Mechanical Specifications:		Unit
Die composition	Silicon wafer, n+ doped.	
Die shape	Rectangle	
Length (±1mil)	200	µm
Width (±1mil)	200	µm
Thickness	4 or 6 or 8 ±1 (1)	mils
Saw street widths (space between each diode chip on the wafer)	60 (X-direction) 60 (Y-direction)	µm
Top pad length	125	µm
Top pad width	125	µm
Top pad composition	Aluminum or Gold (1)	
Back metal (underside of ESD die)	Gold or Silver or AuSn (1)	

ESD-PL02

The ESD-PL02 is a back to back diode configuration in a 18.3x17.5x6.0 mils flip chip.

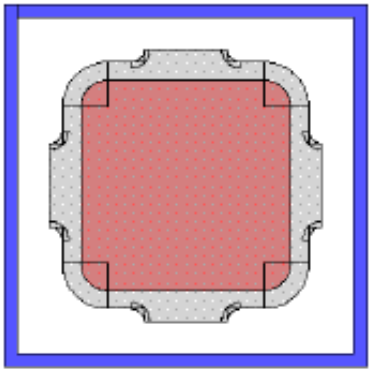


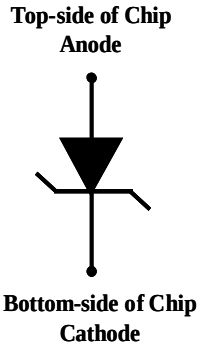
Full Ordering Part Number	
Pad Material (RoHS Compliant)	**OnChip P/N**
Al/1%Si pads - 1.8 Micron thick	ESD-PL02WR
5.0um Electroplated Au Bumps. Adhesion layer will be 2,000 Angs TiW.	ESD-PL02WFR-Au

Electrical Specifications @ 25°C	Min.	Typ.	Max.	Unit
Diode Breakdown Voltage at 1mA	25	28	-	V
Leakage current at 22V Bias	-	0.1	2	uA
Channel Clamp Voltage during 8kV HBM	-	±30	-	V
In-system ESD withstand voltage per IEC 61000-4-2:				
Contact Discharge *	± 8	-	-	kV
Air Discharge *	± 16	-	-	kV
Input Capacitance at 1MHz, 5V	-	100	150	pF
Peak (ESD) Pulse Current @ 8/20 us	-	-	15	A
Temperature Range:				
Operating	-40	-	85	°C
Storage	-65		150	°C

ESD7979-100V

The ESD7979-100V is a wire-bondable chip of 7.9x7.9x6.0 mils with a top side anode and back side cathode. It clamps at 100V to protect long strings of LEDs. It is available with an Al top metal and Au back metal. Two diodes can be wire bonded together to create a back to back configuration for protection from both positive and negative voltage surge.

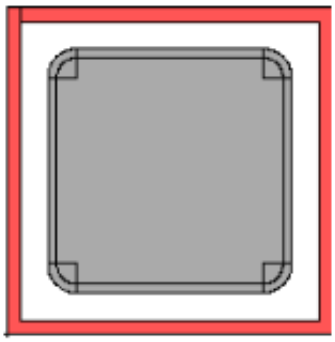


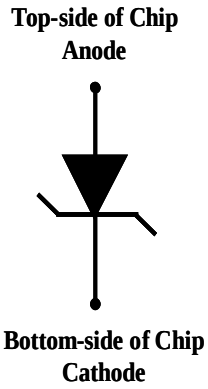


ELECTRICAL CHARACTERISTICS @ 25°C						
SYMBOL	**PARAMETER**	**CONDITIONS**	**MIN**	**TYP**	**MAX**	**UNIT**
V_Z	Zener Diode Voltage	I_Z = 5µA	100	-	-	V
I_R	Leakage Current	V_R = 80V	-	0.5	1.0	µA
V_f	Forward Voltage	I_f = 10mA	0.77	0.82	0.87	V
V_{ESD}	ESD Withstand Voltage	HBM, MIL-STD-883, Method 3015	±8			kV

ESD9595-55V

The ESD9595-55V is a wire-bondable chip of size 9.5x9.5x4 mils with a top side anode and back side cathode. Two diodes can be wire bonded together to create a back to back configuration for protection from both positive and negative voltage surge.

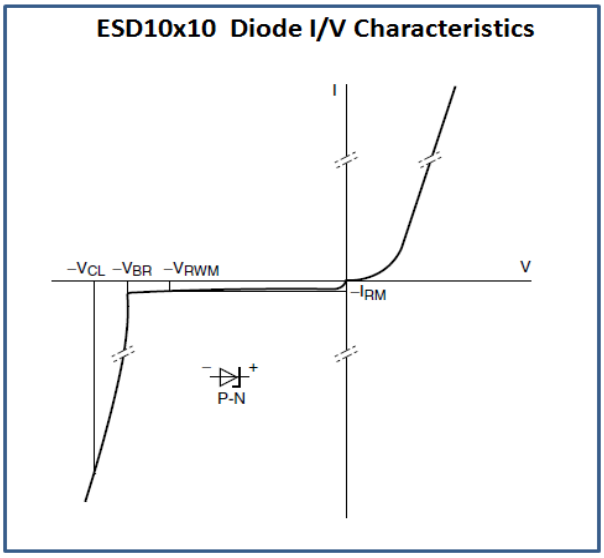


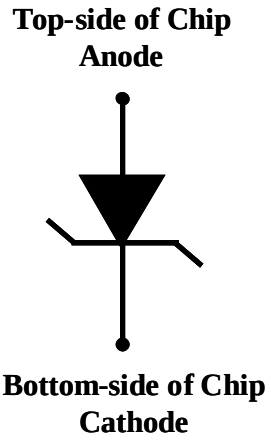


ELECTRICAL CHARACTERISTICS @ 25°C						
SYMBOL	**PARAMETER**	**CONDITIONS**	**MIN**	**TYP**	**MAX**	**UNIT**
V_Z	Zener Diode Voltage	I_Z = 10mA	55	-	-	V
I_R	Leakage Current	V_R = 45V	-	-	0.5	µA
V_f	Forward Voltage	I_f = 10mA	-	-	1.2	V
V_{ESD}	ESD Withstand Voltage	HBM, MIL-STD-883, Method 3015	±8	-	-	kV

ESD10x10

The ESD9595-55V is a wire-bondable chip of size 9.5x9.5x4 mils with a top side anode and back side cathode. Two diodes can be wire bonded together to create a back to back configuration for protection from both positive and negative voltage surge. Available with Al (Au optional) top metal and Au, Ag, or AuSn back metal.



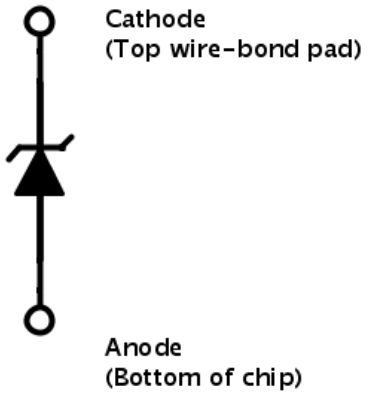


ELECTRICAL CHARACTERISTICS @ 25°C						
SYMBOL	**PARAMETER**	**CONDITIONS**	**MIN**	**TYP**	**MAX**	**UNIT**
V_{RWM}	Reverse Stand-off Voltage			70		V
I_{RM}	Reverse Leakage Current	V_{RWM} = 70V			2	µA
V_{BR}	Reverse Breakdown Voltage	T_A = 25°C		75		V
V_{CL}	Reverse Clamp Voltage	I = 10mA	85		90	
V_{ESD}	ESD Withstand Voltage Human Body Model, MIL-STD-883, Method 3015 Contact Discharge per IEC 61000-4-2 standard		 ±15 ±8			 kV kV

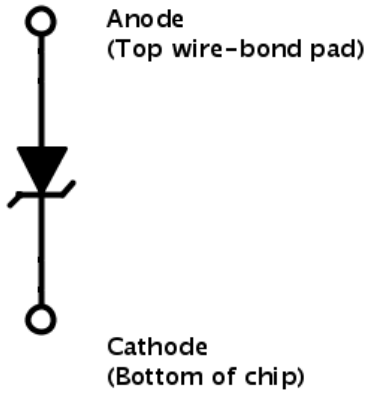
ESD88

The ESD88 chips are available in two configurations. The ESD88PN has a top anode and bottom cathode, while the ESD88NP has a top cathode and bottom anode. Both chips are 8x8 mils with an option for 4 or 6 mil thickness. Front metal is Al (Au optional) and back metal is Au.

ELECTRICAL CHARACTERISTICS @ 25°C						
SYMBOL	**PARAMETER**	**CONDITIONS**	**MIN**	**TYP**	**MAX**	**UNIT**
V_Z	Zener Diode Voltage	5V : I_Z = 10mA	5	-	7	V
		7V : I_Z = 10mA	7	-	9	V
I_R	Leakage Current	V_R = 5V	-	-	0.5	µA
V_F	Forward Voltage	I_F = 10 µA I_F = 20 mA	0.5 0.7	- -	0.9 1.2	V
V_{ESD}	ESD Withstand Voltage	ESD per IEC 61000-4-2 (Contact) ESD per IEC 61000-4-2 (Air)	8.0 15.0	- -	- -	kV



ESD88NP



ESD88PN

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