

ESD Model at Waterjet Deflash Process of Semiconductor Tapeless Leadframe Package

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Abstract—This paper presents an ESD (electrostatic discharge) model using Charged Device Model (CDM), Machine Model (MM), and with package electrical modeling, at waterjet deflash process.

Keywords— ESD; waterjet; charged device model; CO₂ bubbler.

I. TRIBOCHARGING AT WATERJET STATION

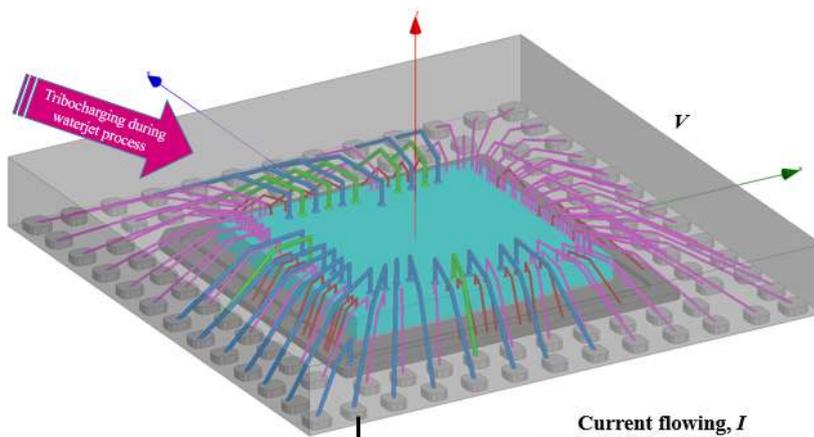
- Waterjet deflash process utilizes highly pressurized water to clean the metal lead surfaces of the semiconductor tapeless leadframe package
- Upon contact with the device, ESD through triboelectric charging or simply tribocharging happens due to fast frictional contact between the two materials
- Charges are dissipated from the unit passing through the DI water, onto the rollers, to the machine body, and onto the ground



Fig. 1. Waterjet deflash process illustrating the tribocharging.

II. ESD MODEL WITH PACKAGE MODELING

- ESD (electrostatic discharge) models namely Charged Device Model (CDM) + Machine Model (MM) could be used to illustrate the charged device with discharge path to the ground through the deionized (DI) water
- CO₂ bubbler is added to lower the DI water’s resistivity, eventually minimizing the effect of tribocharging
- In CDM, it is assumed that the device, along with its parasitic RLC (resistance, inductance, capacitance), has already been charged-up during the waterjet deflash process



- DI water and CO₂ bubbler parameters are usually given as resistivity
- Given the values for resistance,

$$\begin{aligned}
 R_{DI} &= 17M\Omega \\
 R_{CO_2} &= 0.31M\Omega \\
 R_{eq} &= R_{DI} \parallel R_{CO_2} = \frac{17M\Omega \times 0.31M\Omega}{17M\Omega + 0.31M\Omega} \\
 R_{eq} &= 0.304M\Omega
 \end{aligned}$$

- With lower R_{eq} , higher current I could flow to the ground
- Therefore, more amount of charge Q of the package or device could be discharged at a period of time

- Charge Q is generated through tribocharging during the waterjet process
- And voltage V is expressed in terms of the charge Q and capacitance C in the following equation:

$$V = \frac{Q}{C}$$

- The amount of charge Q that is dissipated or discharged from the device to the ground is determined through the equivalent electric current I measured
- By ohms law,

$$I = \frac{V}{R_{eq} + R_{tg}} \text{ and } I = \frac{\Delta Q}{\Delta t}$$

- R_{DI} = resistance of DI water
- R_{CO_2} = resistance of CO₂ bubbler
- R_{eq} = equivalent resistance of R_{DI}/R_{CO_2}
- R_{tg} = resistance to ground of the machine roller + machine body, with specs value of less than 10Ω