Water Washable Coatings for Plasma Dicing Processes

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Abstract

As the dimensions of thin and tiny die trend smaller, they become candidates for laser assisted plasma singulation (LAPS), otherwise referred to as plasma dicing. The process involves creating a patterned mask whereby the plasma chemistry penetrates open areas and down into the substrate. When complete, the mask is cleaned leaving fully singulated die. Water washable coatings for mask creation are preferred. Ideally, they should exhibit high plasma resistance and be tuned for good laser interaction. Daetec's washable coatings exhibit thermal resistance over 300°C, making them the most unique materials on the market.[1] These are cast from water, processed, and removed by water. Simple spin coating achieves <5μm coverage while conforming over high features is achieved by "nozzle-less" spraying with equipment designed by Ultrasonic Systems, Inc. (USI).[2] A ultrasonic head breaks the liquid into small drops to form a fine spray that deposits on faces and around corners. Once coated, substrates proceed to laser processing, tuned to delicately break through the washable layer with little or no effect to the substrate. Desired coating compositions use heat resistance, high melt viscosity, and sufficient type and amount of absorptivity for good laser engagement. These properties minimize snow-plow ("re-cast") effects during laser patterning and further minimizing the need for substrate polishing (descum) preceeding the plasma process. Etching proceeds by the proven Bosch DRIE switched process for straight profiles using the Mosaic™ platform with Rapier-S modules as produced by SPTS.[3] Plasma etch selectivity for silicon vs. erosion of Daetec's washable coatings as Si:mask, is observed to be 1,000:1, or greater.[4] The process is finished with simple DIW rinsing, leaving the surface free of residue and ready for die pickup. This paper presents further details on plasma dicing using water washable coatings.

Introduction

A great deal of attention is being focused on die singulation to minimize yield loss from chipping and lost die due to vibratory action of the saw that causes pushing and pulling small die from the adhesive carrier (film frame tape). Yield loss trends upward for thin substrates (e.g. 200 microns or less), those having small die (e.g. <2mm on an edge), and fragile materials (e.g. gallium arsenide). As new opportunities in 5G and automotive present greater performance challenges where tiny irregularities from mechanical sawing are being scrutinized. These points, together with added usable real estate conversion from smaller kerf size, creates an attractive solution in LAPS (plasma dicing).

The process flow plasma dicing is similar to conventional laser dicing, namely, coating, cutting, and washing. Plasma etching replaces a mechanical saw for die separation (singulation). While a customer's number of steps may vary, four steps as shown in Fig. 1.

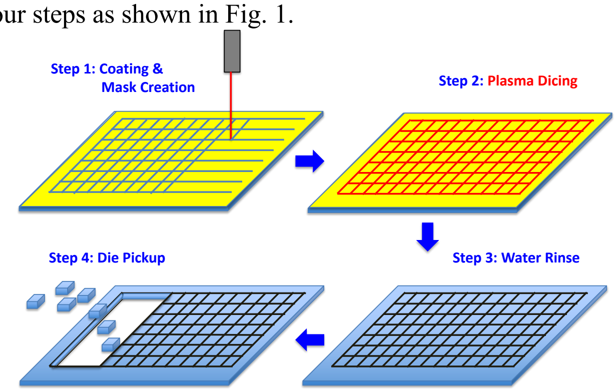

Fig. 1. Four steps for LAPS, 1) laser mask creation, 2) plasma dicing, 3) water rinse, and 4) die pickup.

Water Washable Coatings

Aqueous washable coatings dissolve in water, preferably of high purity (e.g. deionized water, DIW). They may be cast from aqueous or organic media. Plasma dicing products contain multi-component thermal resistant materials as phenyl containing resins R1 & R2, a UV agent (UVA), and rinse aid (RA) shown in Table 1.

Table 1. Water washable coating concentrates for plasma dicing. Dilution is recommended before use.

DaeCoat™ Concentrate	Resin Type*	Rinse Aid*	UVA*	Biocide & inert Ingredients
534G	R1	✓	↑↑	✓
528G	R2	✓	↑↑	✓
528R	R2	✓	↑↑↑	✓

* Thermal Resistant

Chemistry

Polymer thermal resistance improves with the presence of aromatic rings (phenyl groups). They are stable due to their lower reactivity, higher energy of oxidation, and aromaticity, a phenomenon based upon electron delocalization (Fig. 2).