Characterization of Silicon Die Filleting Process through Dispensing

Ludovico Cestarollo, Mohammed Alhendi, Darshana Weerawarne and Mark Poliks

Flexible hybrid electronics integrates rigid electronic components with printed features on flexible substrates, allowing the final product to stretch and bend while still preserving the operational integrity of conventional electronics. Components of various thicknesses may be placed on the substrate and, in order to be integrated with each other, robust electrical interconnections are to be printed between different leveled surfaces of the substrate. Rigid components present sharp edges that constitute points of high mechanical stress for the interconnects, which consequently are more likely to fail in these locations, rather than on the other flat surfaces on the substrate or on the top of the components. It is of crucial importance to effectively fillet the sides of the components, in order to create smoother surfaces that climb over the edges, offering a more robust solution for the printing of electrical interconnections.

Despite this concern is of crucial importance for several applications in flexible hybrid electronics, it has not received much attention in the literature. Gu et al. have published a paper in 2017 where they explain the process they have developed to fabricate aerosol jet printed fillets. However, in such a process where precision at the micron scale is not a concern, dispensing offers a more convenient solution than aerosol jet printing. In fact, dispensing can deposit large quantities of material at a much faster speed, still obtaining precise and repeatable results for the requirements of this kind of application. This paper presents the work done to characterize the dispensing process of die fillets using DuPont 5036 Encapsulant as the filleting material. Silicon dies were filleted using different levels of dispensing parameters of interest. Then, conductive lines were printed over the dies and the fillets using aerosol jet printing (AJP) technology, in order to assess the quality of the fillets. The quality was assessed through the resistance measurements of the AJP-printed lines; the larger the resistance, the worse the fillet. The experiment was conducted following design of experiment (DOE) rules, in order to determine which dispensing factors significantly affected the quality of the fillet. The optimal factor levels were defined, and the results of the DOE analysis were supported by laser microscopy analysis of the samples.