Pad Crack detection by APC @ Aluminum Wire Bonding

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Abstract

In frontend semiconductor production facilities APC is since many years' standard, enhancing throughput, quality and stability at the same time.

APC @ Backend – still a challenge! Processes are faster, sometimes by a factor of 1000. This increases the amount of data and is therefore also challenging the performance of equipment interfaces and IT infrastructure. Also new analysis methods are needed to analyze this huge data amounts and create useful out of control action plans (OoCAPs).

One of the most critical – if not key processes – is wire bonding [PIC1]. The combination of electrical, electronically, mechanical settings on the one side and human interference and handling on the other side create a complicated framework influencing the performance of this process as well as the quality of the product.

100% control of every single bond seems to be necessary to guarantee the expectations of automotive industry. With the help of modern IT systems and software this is possible today!

Data acquisition

Using SECSGEM interfaces as a standard, the expert wire bond APC group decided to collect 2 trace parameters and about 15 event parameters – such as input settings - as well as tool alarms per bond. This enables a general overview as well as a detail examination at every detected abnormality.

Critical Key indicators

The key indicators are basically computed out of the trace parameters. These indicators reflect quality as well as stability factors. [PIC2] A detailed analysis shows that these indicators are very often related to mechanical issues – as to be expected by the mechanical character of equipment setup. Tool to tool differences are easily detected and controlled.

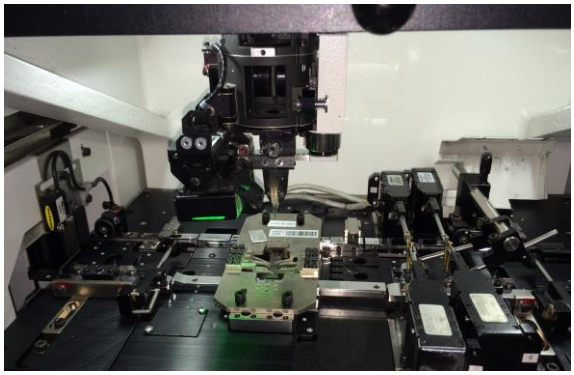
Findings and correlations

It was found that traditional quality indicators like the pull/shear tests only give partial information on quality and stability of the process. Also optical inspection is in most cases only used for sampling and only delivers information on the surface of the product. APC data instead deliver data on 100% of the units – of course with the need to be interpreted the right way. The – of course often indirect – indication of process deviations is clearly evident [PIC2]. In many cases the deviations point to mechanical issues which can be avoided by an APC controlled setup procedure. Time consuming tests like pull/shear tests – which are standard in today's wire bond process control procedures - can in principle be minimized, if not replaced by using APC data. The data is even fine enough to indicate which finger of the clamp might need adjustment – a very time saving and useful information for operators and technicians. The special focus of this paper is on the detection of pad cracks [PICs3/4]. We can show that APC data analysis is not only capable to detect risky process settings: by controlling the critical output parameters it is possible to stop the tool on a failed setup procedure as well as on a running process which suddenly may show a drift in one or several of the critical parameters. The use of western electrical rules enables this method to be used in a typical production environment.

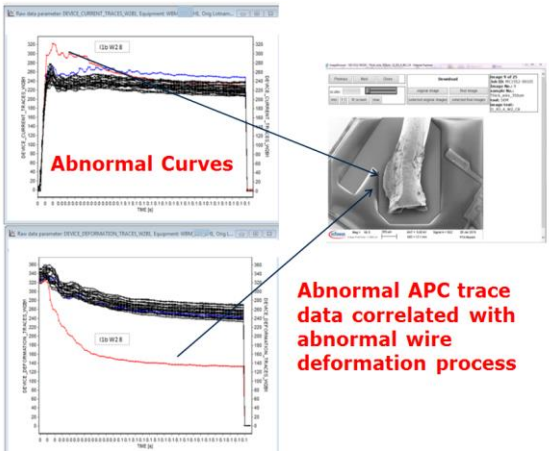
Summary and Outlook

In this paper is clearly shown the usefulness of APC data analysis in wire bond processes to detect and eliminate pad cracks in production. This concept can clearly also be extended to other process deviations as well as other processes like die attach or sawing. We expect a similar impact to backend processes as we have seen in frontend – of course knowing that there are still a lot of hurdles to take.

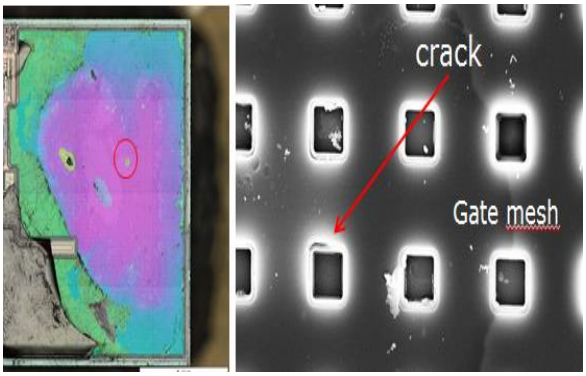
Dear backend equipment vendors – we count on you supporting us!



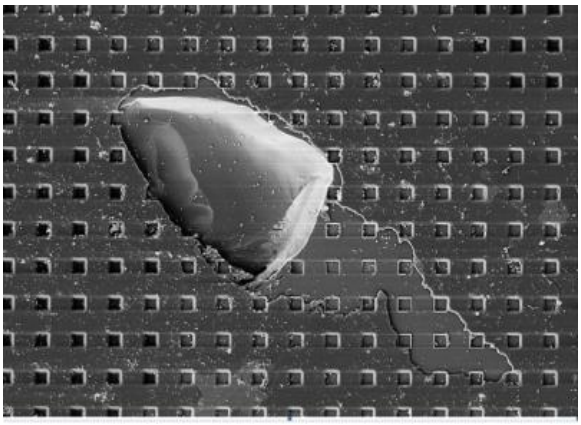
PIC1: Wire bonding process



PIC2: Critical output parameters indicating process issues



PIC3: Pad crack detected by Duebotzky method



PIC4: SEM picture of severe pad damage by wedge impact