Conventional vs. Advanced Sample Preparation Method

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1. Electronic Materials

Electronics is the branch of engineering that pertains to the control of electrons for useful purposes. Electron flow can occur in a vacuum, gas or liquid, as well as in solid materials that allows either restricted (semiconductor), nearly unrestricted (conductor), or totally unrestricted (superconductor) flow.

By 1980 the industry had grown to over $200 billion, and by 1990 sales had exceeded $650 billion. The projection for industry sales in the year 2000 is over $1.4 trillion. Even according for inflation, the real growth of the electronics industry has been impressive.

Electronics products are getting more and more complicated, engineers always try to put numerous components into a small “black box”. It is no doubt that the quality and reliability of the final products rely on the performance of the individual components. However, that is always a headache problem for electronic industries. Metallographic examination of the cross section is a well-known and commonly accepted inspection method for electronic items.

However, most of electronic inspectors may face a problem of that the materials they are grinding and polishing are more complicated and difficult than their expectations. And they may have never learned how to handle the multi-matrix materials, while what they have learned from universities are properly how to prepare the homogeneous metals like steel, copper or aluminium alloys.

Basically speaking, the conventional sample preparation method start with 240 grit silicon carbide paper for planar grinding and then 600 grit, 1200grit, followed by 0.3 micron aluminia as rough polishing and 0.05 micron aluminia as final polishing.

This method has been used for more than 50 years and it is still using by a lot of people. They do the inspection works every day but they don’t know the things they are looking at may not be the “true microstructure”.

In the following chapter, we try to compare the results of the advanced sample preparation method versus the conventional one.

1.1 Components—Resistor & Capacitor

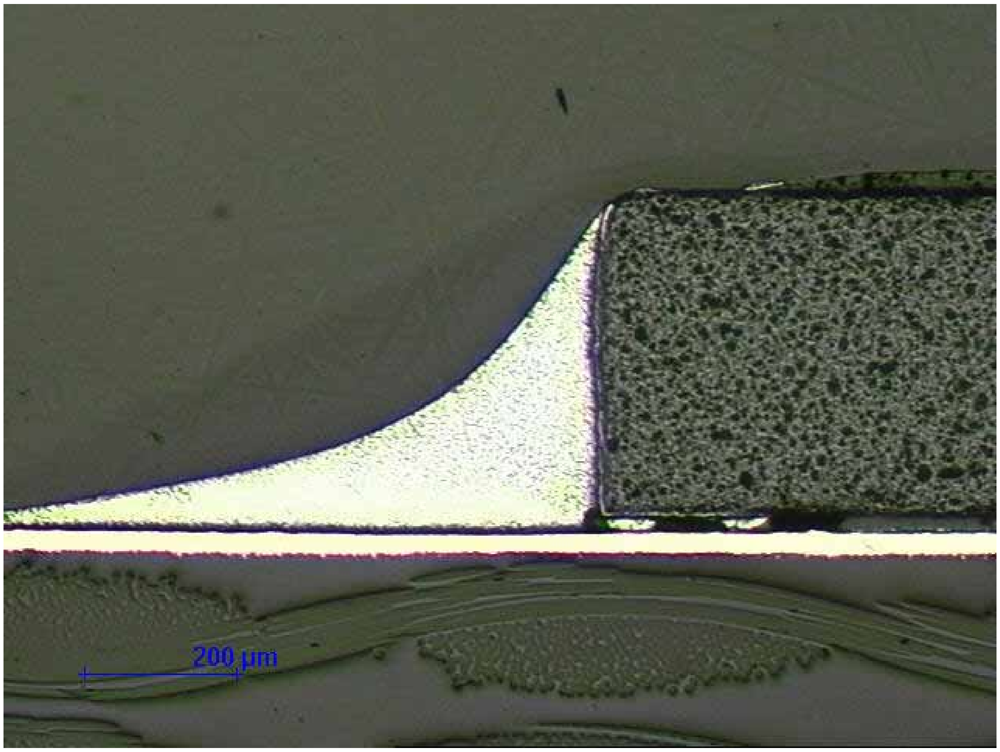


Fig.1 The captured image of surface mounted resistor, 50x

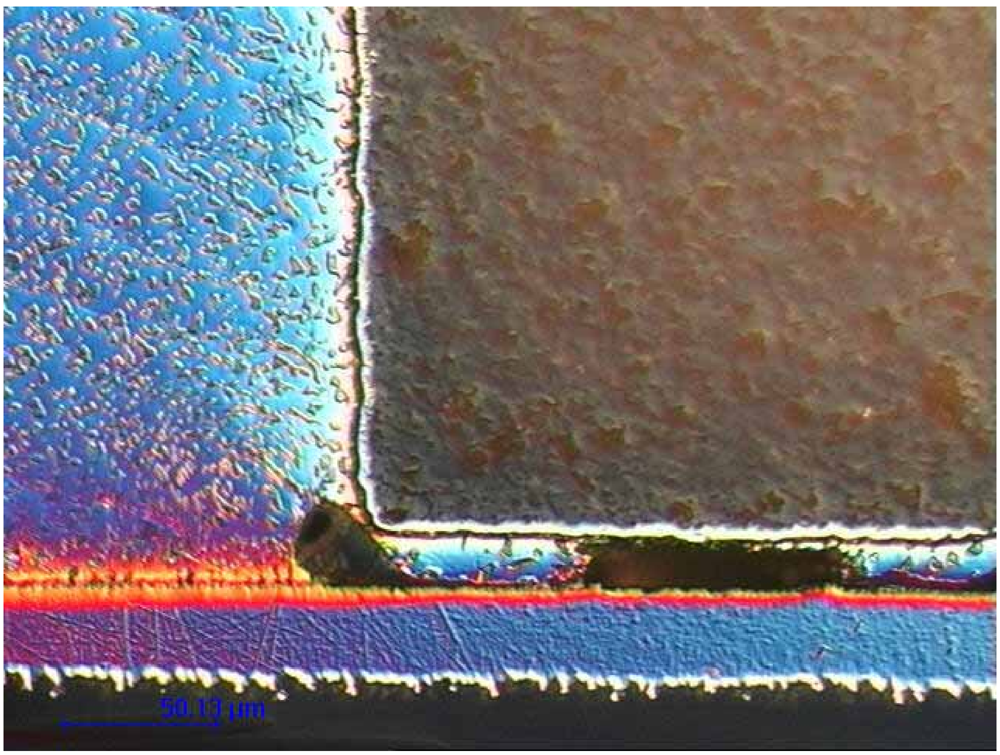


Fig.2 Same sample as fig.1, DIC blue, 200x

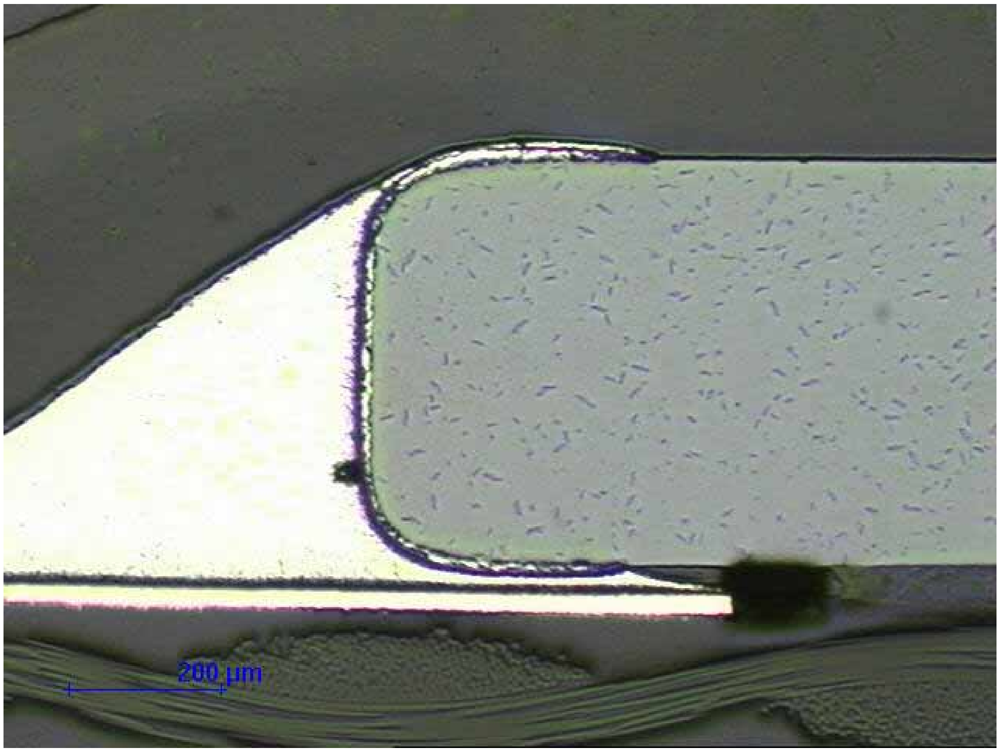


Fig.3 the captured image of surface mounted capacitor, 50x

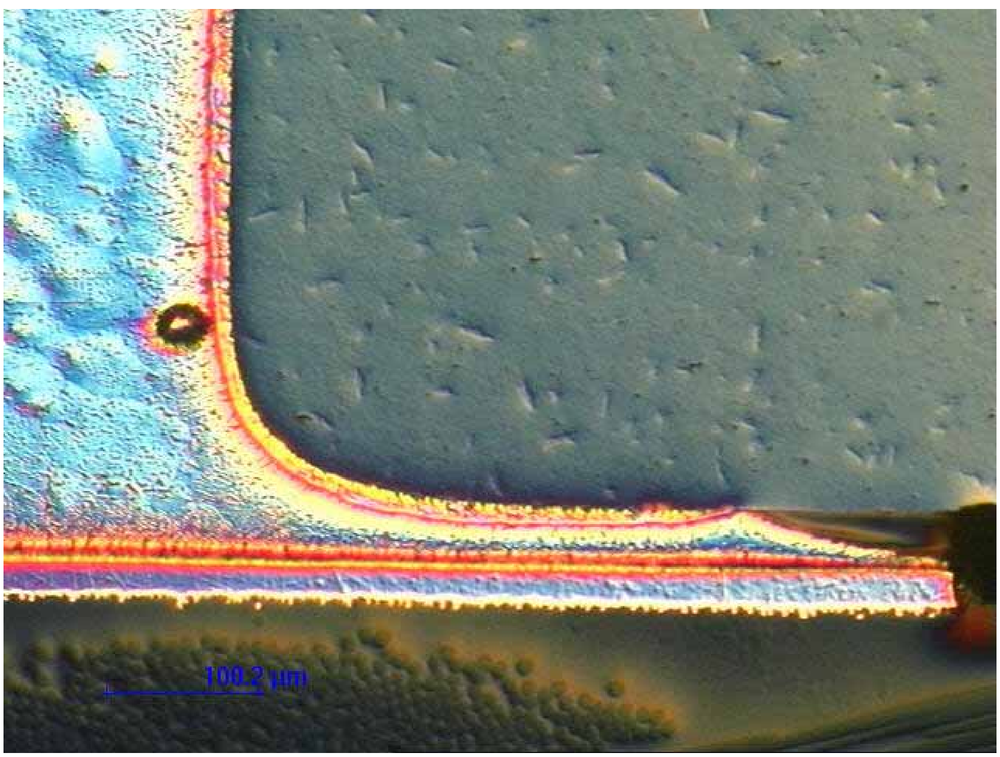


Fig.4 Same sample as fig. 3, DIC blue, 100x

1.2 Through-holes

Through-hole(TH) has been the dominant method of attaching components to PCB since the invention of PCB technology. The through-hole components inserted through predrilled holes on a PCB. The wire leads are then clinched, trimmed, and soldered. The leads of these components serve the dual purpose of providing circuit connectivity, by being soldered to the circuit paths, and acting as a secure mounting structure to hold the component in place.

The following captured images show the results of each step throughout the sample preparation process.

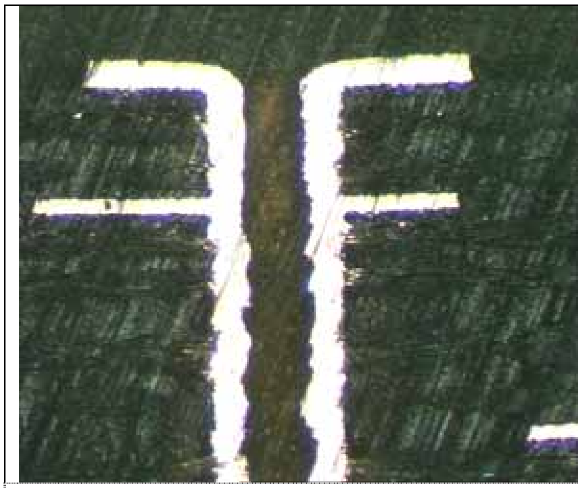


Fig.5a Traditional method, 240 grit, 50x

Fig.5b Buehler method, 240 grit, 50x

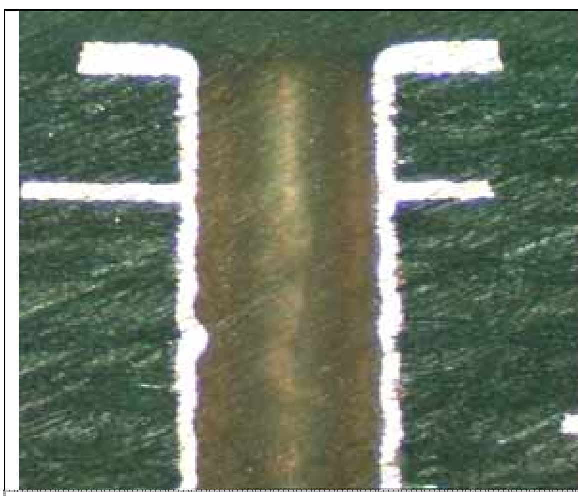


Fig.6a Traditional method, 600 grit, 50x

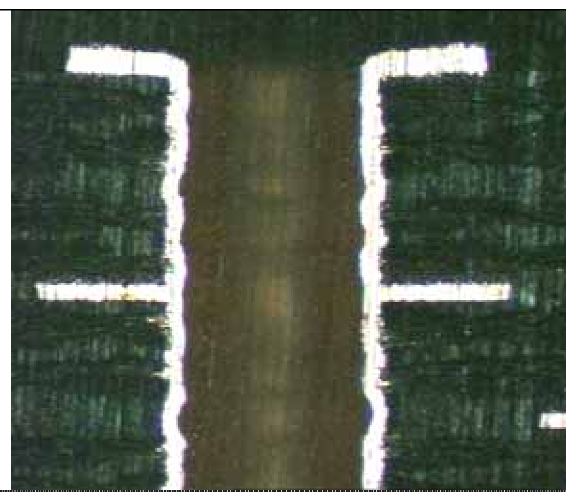


Fig.6b Buehler method, 600 grit, 50x

Fig.7a Traditional method,1200grit, 50x

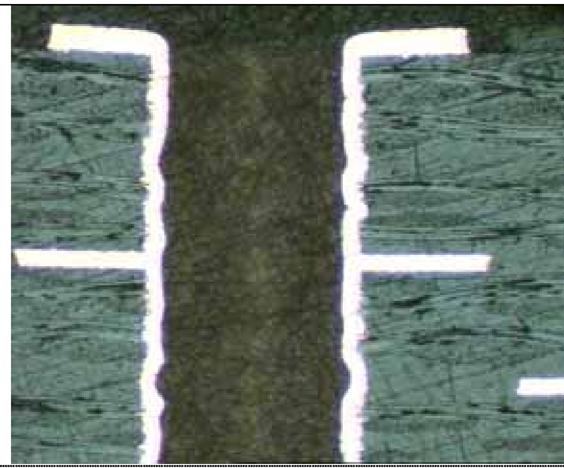


Fig.7b Buehler method, 800 grit, 50x

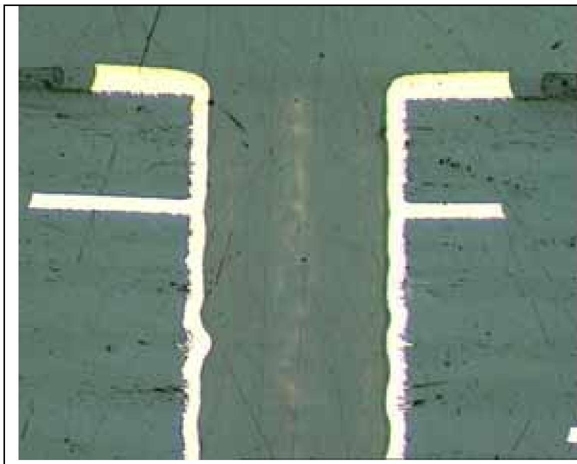


Fig.8a Traditional method, 0.3 μm alumina on Microcloth, 50x

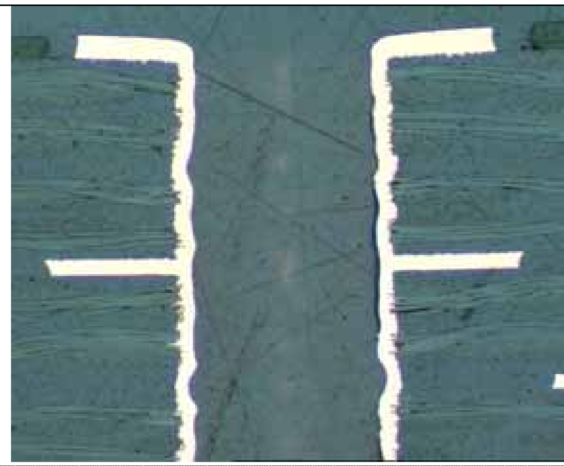


Fig.8b Buehler method, 3μm diamond suspension on Texmet 1000, 50x

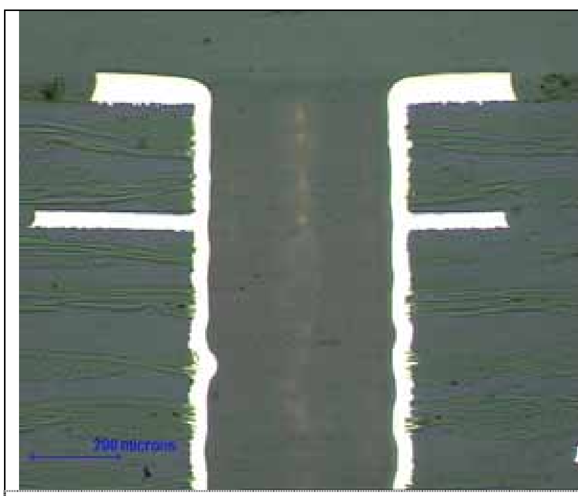


Fig.9a Traditional method, 0.05 μm alumina on Microcloth, 50x

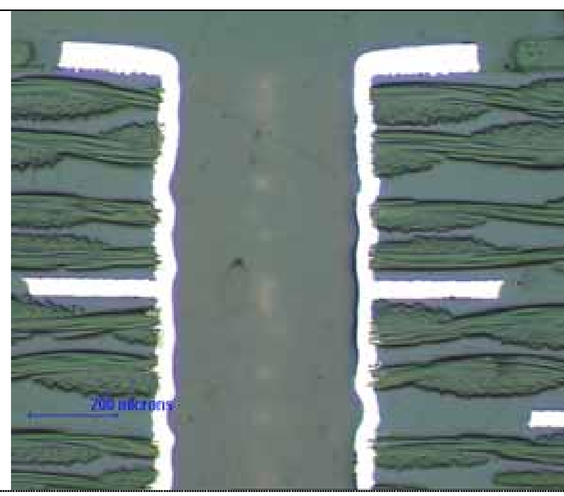


Fig.9b Buehler method, 0.05μm colloidal silica on Chemomet, 50x

Fig.10 The enlarged image of fig. 5a, the traditional method, 50x

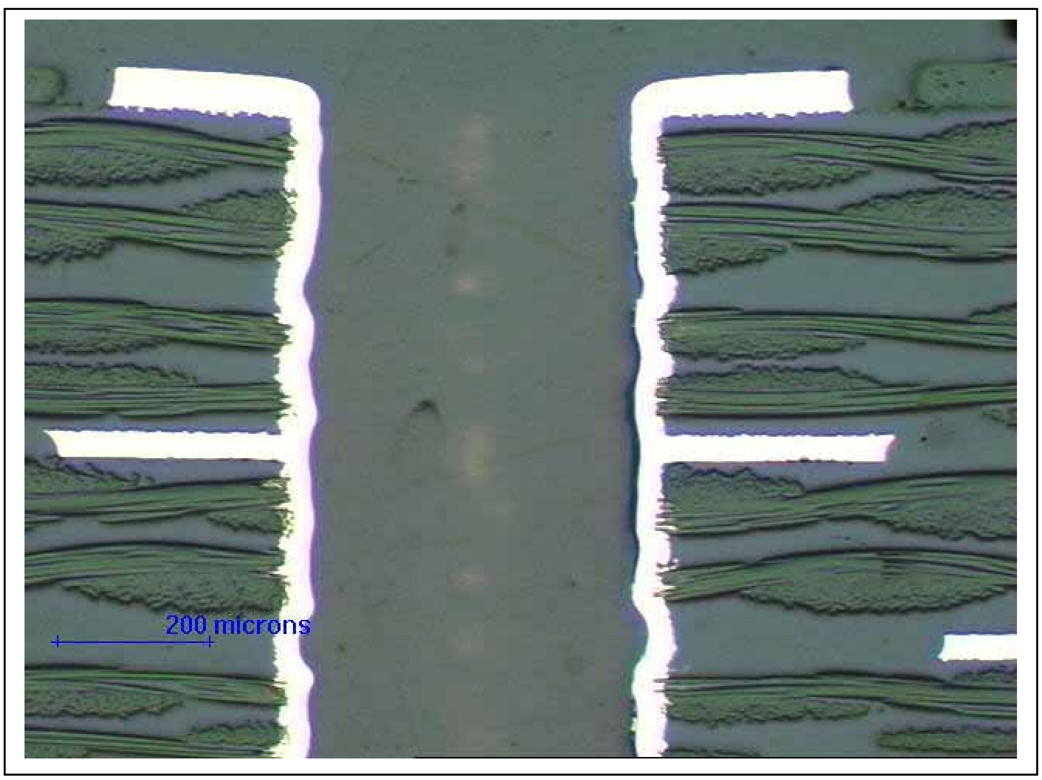


Fig.11 The enlarged image of fig. 5b, the Buehler's, 50x

1.3 Wafer in IC

Normally, people use silicon carbide paper to remove materials in their sample. However, once they face some hard but brittle material, like wafer in IC. They may face a problem of “chipping” on the wafer surface, because of the brittle property of silicon, scratches (induced from precious step of grinding) are almost impossible to be removed by high grit abrasive paper, such as P2400 or P4000.

The following figures show how to use different kinds of grinding and polishing clothes to remove the damaged materials.

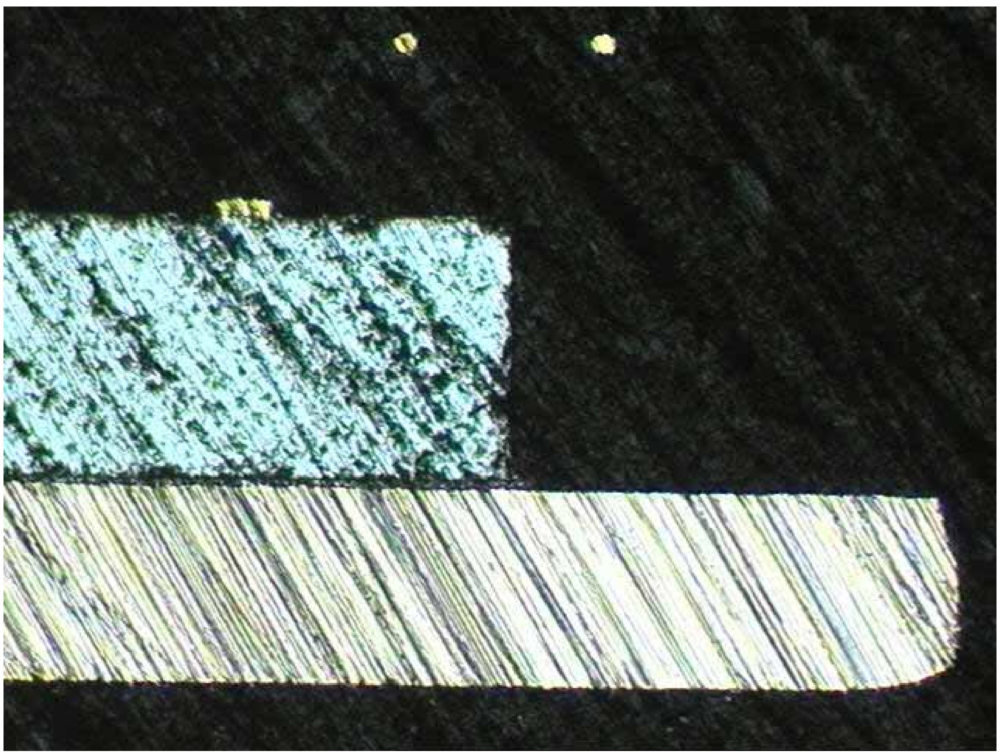


Fig. 12 The captured image of wafer in IC after 600 grit, 50x

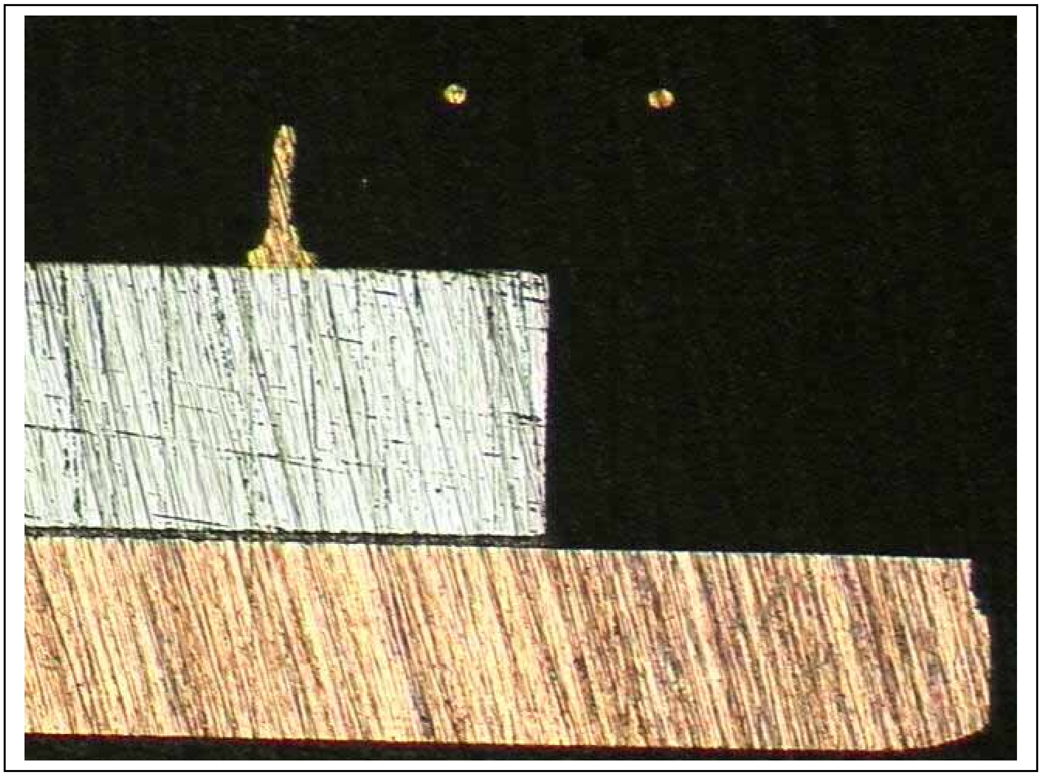


Fig. 13 The captured image of wafer in IC after 15 μm diamond suspension on Texmet P, 50x

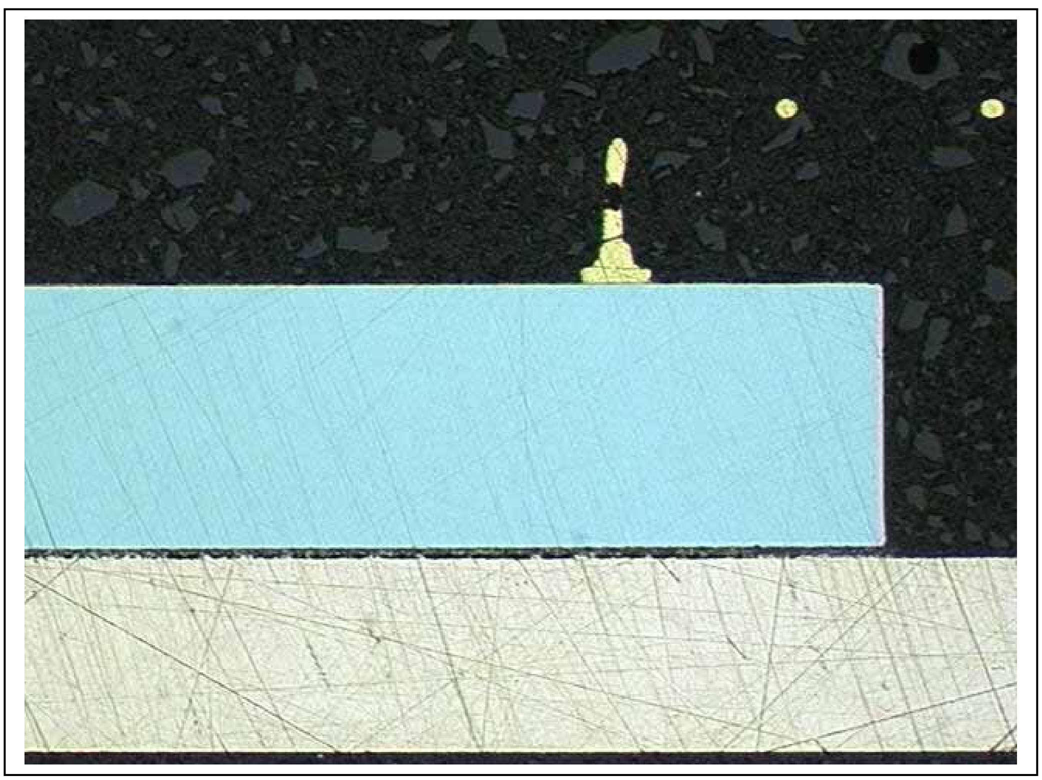


Fig. 14 After 9μm diamond suspension on Texmet 2000, 50x

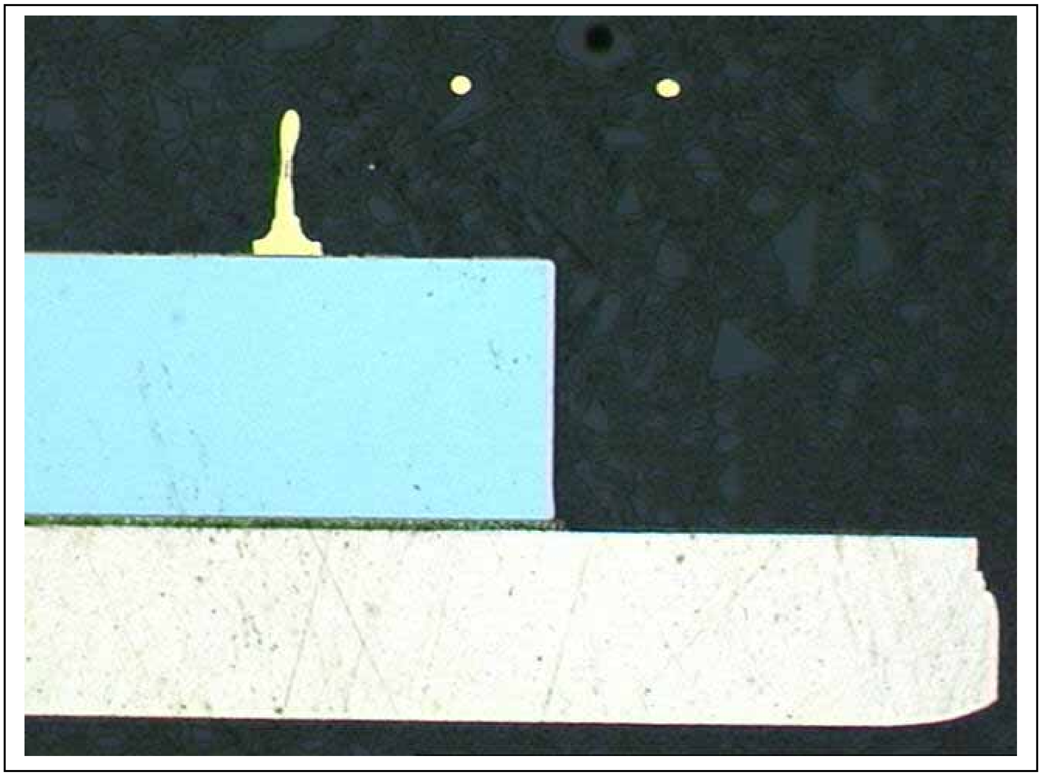


Fig. 15 After 3 µm diamond suspension on Texmet 1000, 50x

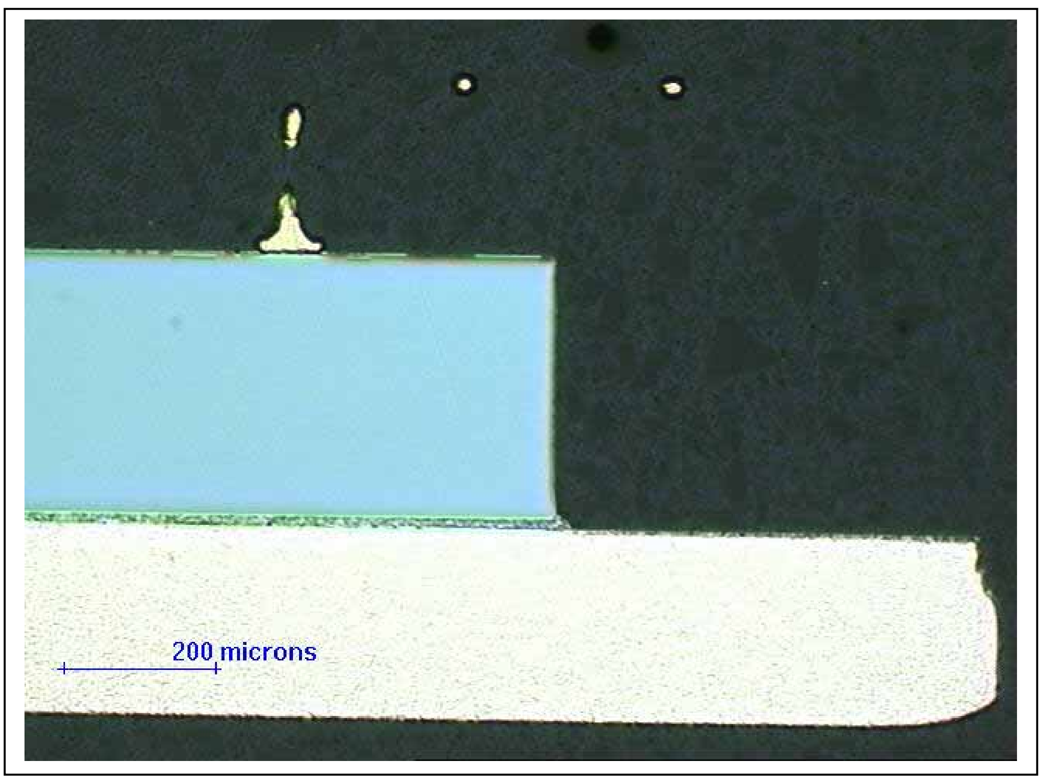


Fig. 16 After 0.05µm colloidal silica on Chemomet, 50x

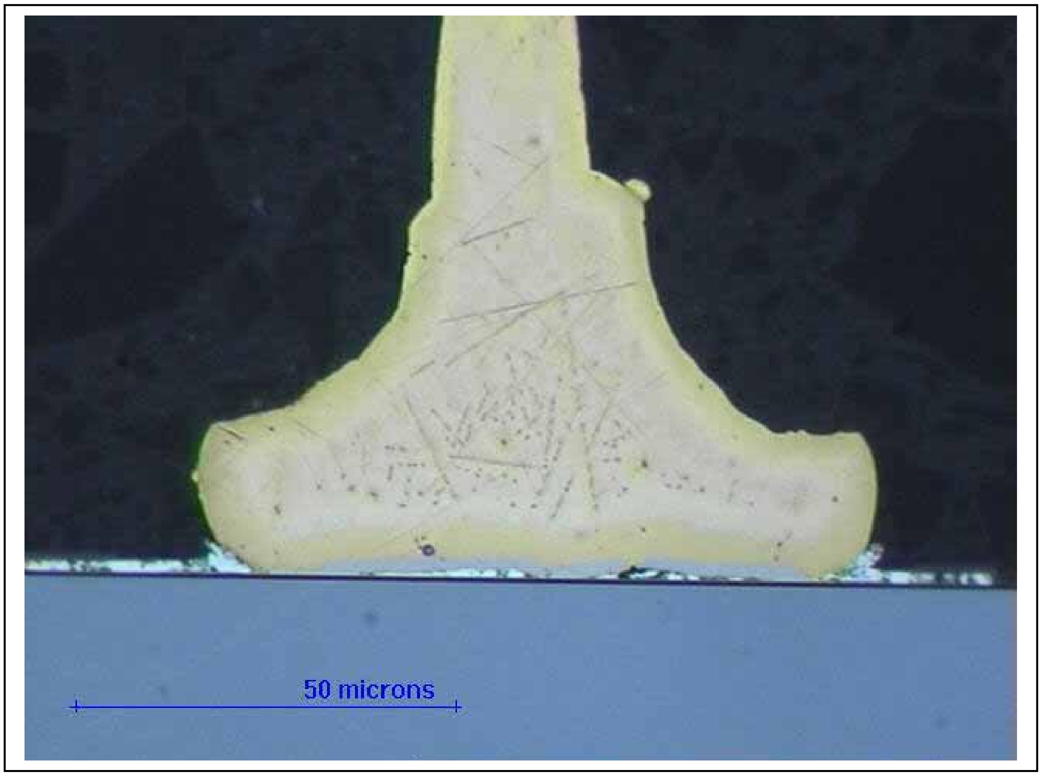


Fig. 17 Same area as fig.16, 500x, scratches on wafer were removed but some scratches still remained on nailhead wire bond

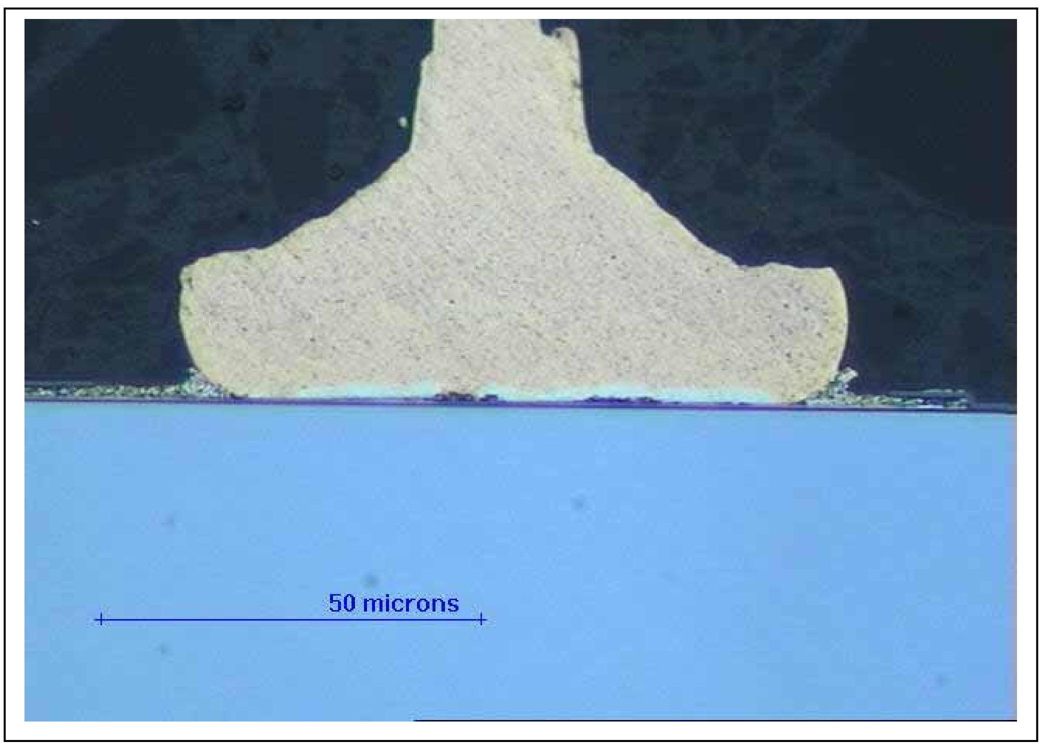


Fig. 18 Same area, situation improved after polished with Masterprep (0.05 μm alumina) on Microcloth supreme, 500x

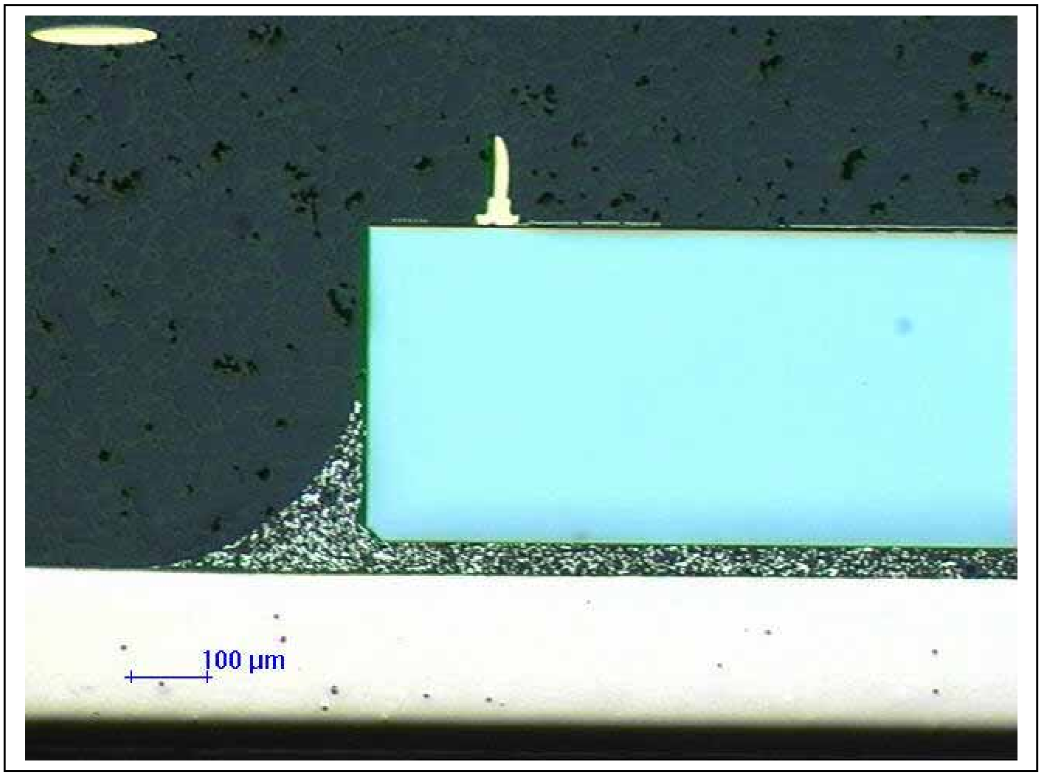


Fig.19 Another sample, same grinding/sample integrity steps but polished with 1:1 mixture of Masterprep & Mastermet2 on Microcloth Supreme, 50x

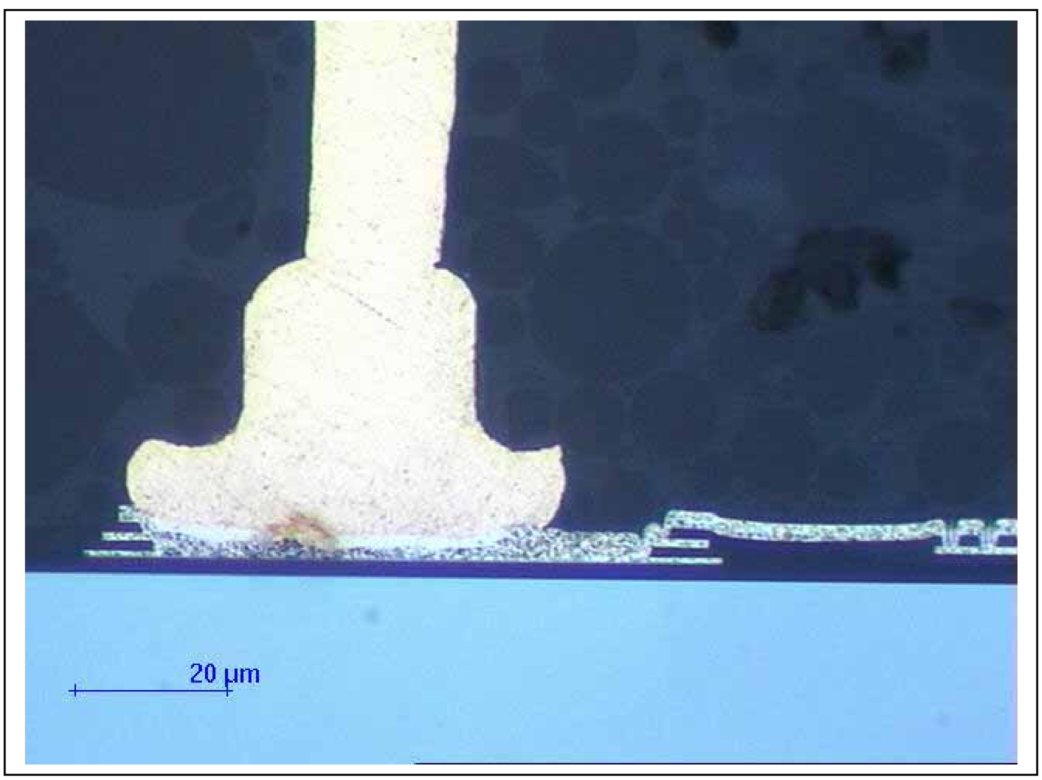


Fig.20 Same sample as fig. 19, wire bond area, 500x

1.4 PCB Weld Types

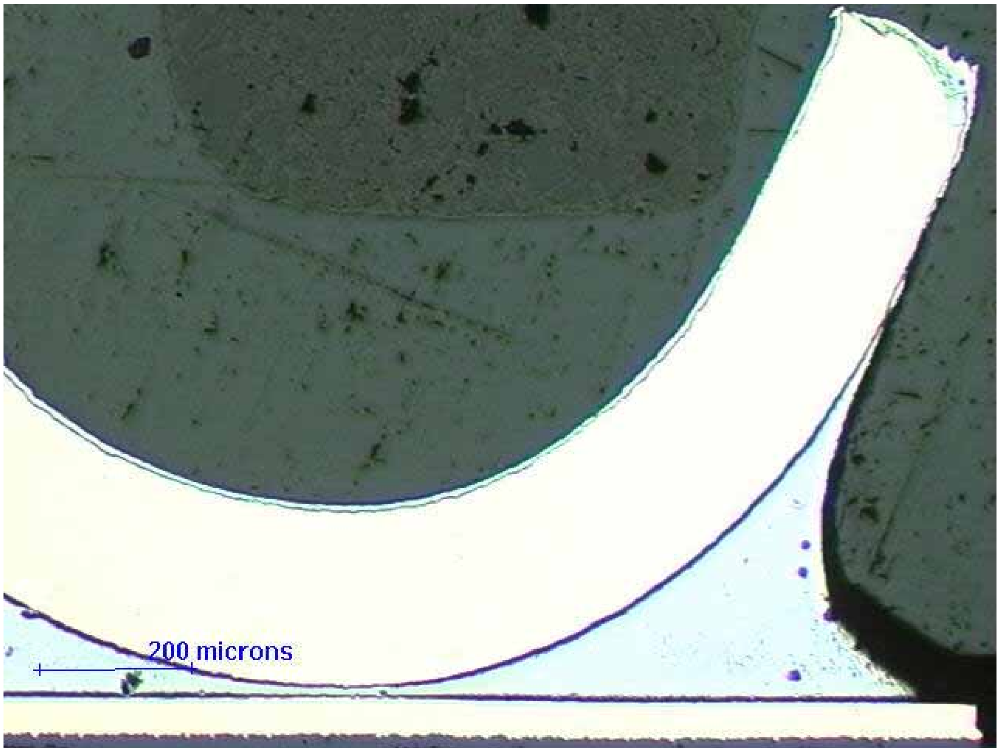


Fig.21 The captured image of the J-lead configuration, 50x

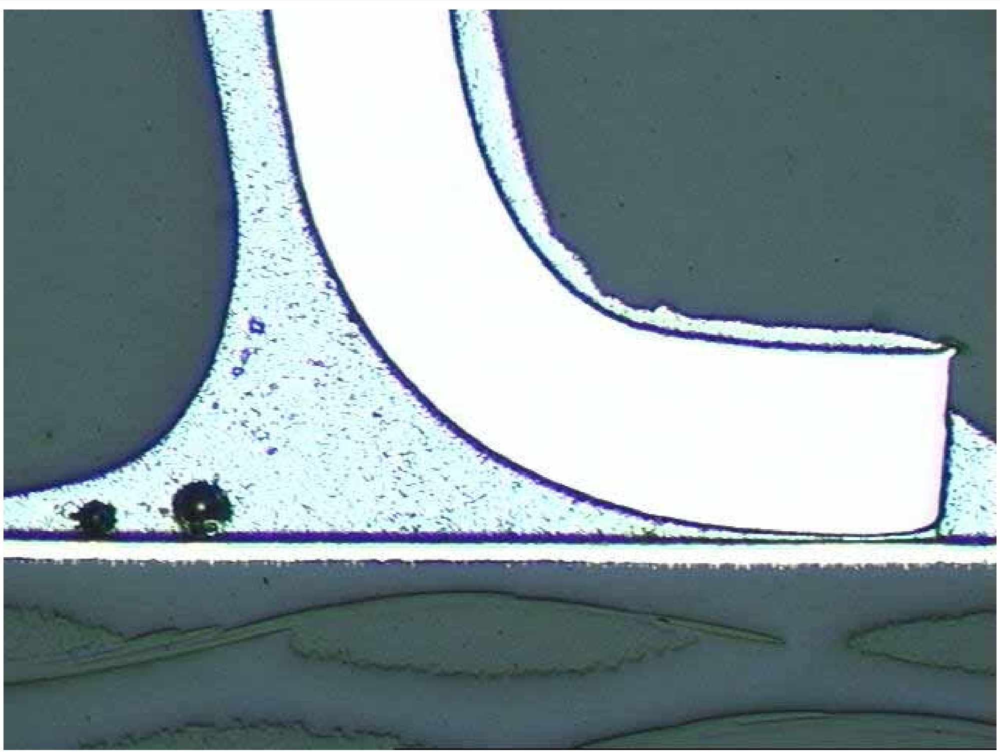


Fig.22 The captured image of the Gull-wing lead of the SMC, 50x

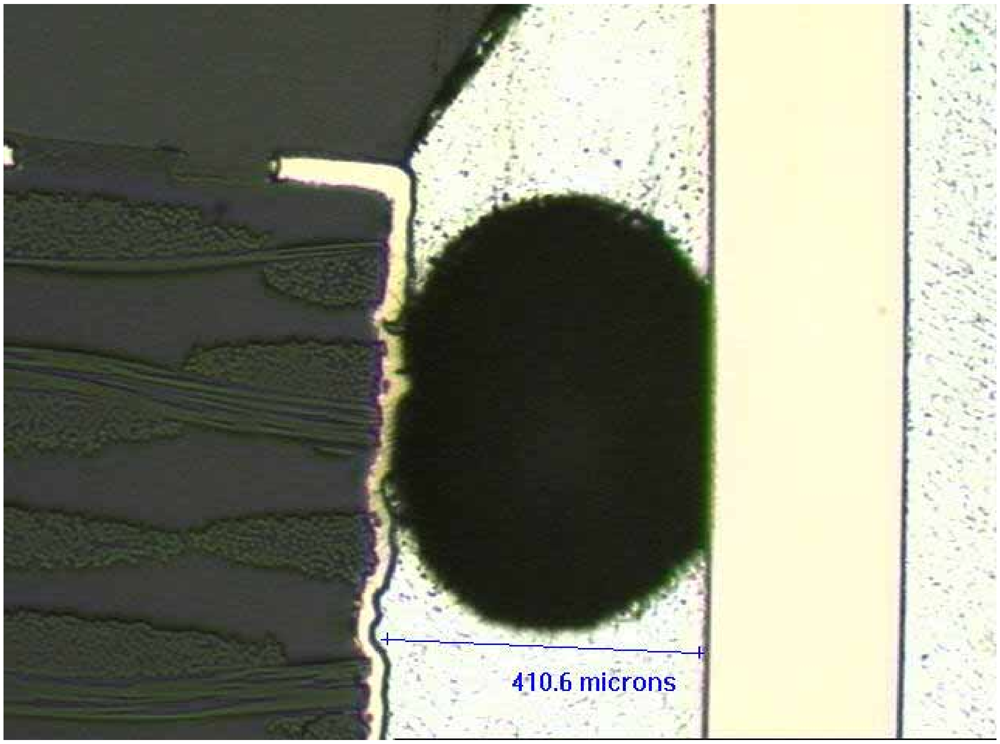


Fig. 23 The captured image of a through-hole weld with a BIG void, 50x

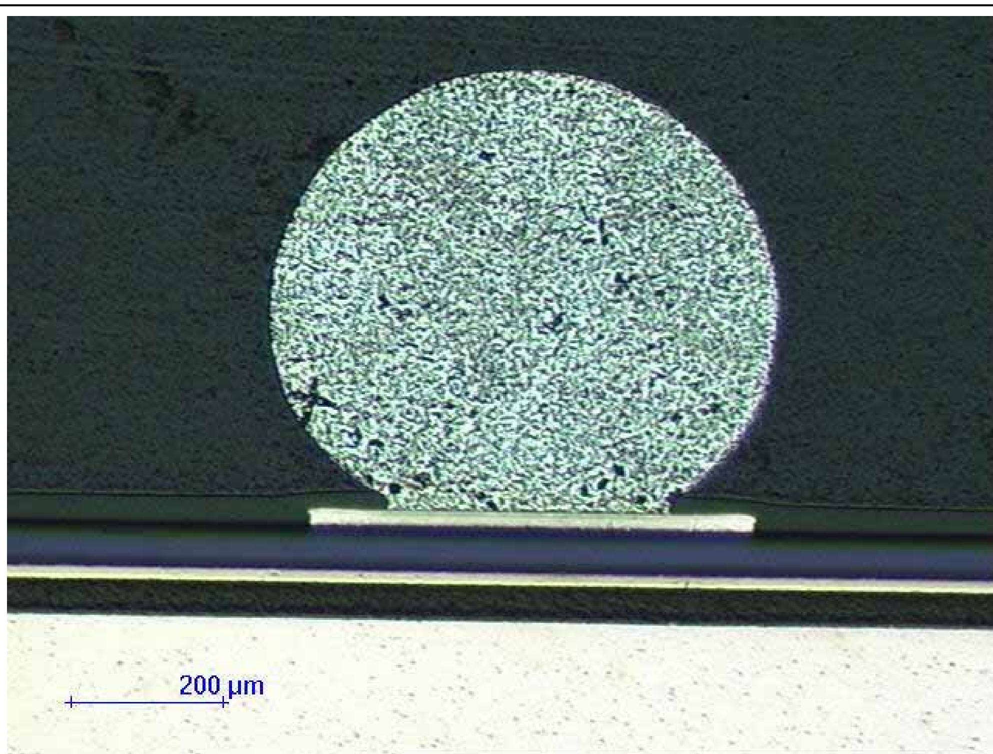


Fig. 24 The captured image of a BGA solder ball, 50x

2. Sintered steel

Sintering is a process that particle coalescence of a powdered aggregate by diffusion that is accomplished by heating at an elevated temperature. Manufacturing of sintered steel parts is the contribution of powder metallurgy. The most common way to produce the sintered steel products is Metal Injection moulding (MIM), very fine steel powder was mixed with certain proportion of plastic binder, the mixture was injected into a mould and gave semi-finished product, it can be any shape, e.g. gear, bearing or watch case. The process is similar to the plastic injection moulding but the injection temperature is a little higher, still below 200 °C. The semi-finished product are then put into high temperature oven, over 1000°C, to burn away to plastic binder and leave steel only.

If the cross-section of the sintered steel part was made, it is not difficult to find out there is still some pores in the core. The percentage of pore is also an important criterion for the acceptance of the sintered steel. However, if the sample preparation method is incorrect, the area percent of the pores may be smaller or larger.

In order to evaluate the effect of sample preparation method to area percent of pore in the sample, a sintered steel part was cut into two pieces. One side was subjected to perform the conventional method and the other side for the Buehler's method.

After final polishing, the images were captured (Fig.25 & 26), and the area percent of pores were counted by Omnimet Enterprise Image Analysis System (Fig. 27 & 28). It is not difficult to discover that the area percent of the conventional sample preparation method is larger than the Buehler's method for 6%.

After carefully inspected the samples, relief could only be observed on the conventional prepared sample, the pore edge was rounded off by the polishing cloth and the alumina powder, so that the pores look bigger and the area percent is larger than the Buehler's method.

From the above results, we can conclude that proper sample preparation method is not only for the aesthetic purpose of the sample but also it would affect our analysis quantitatively.

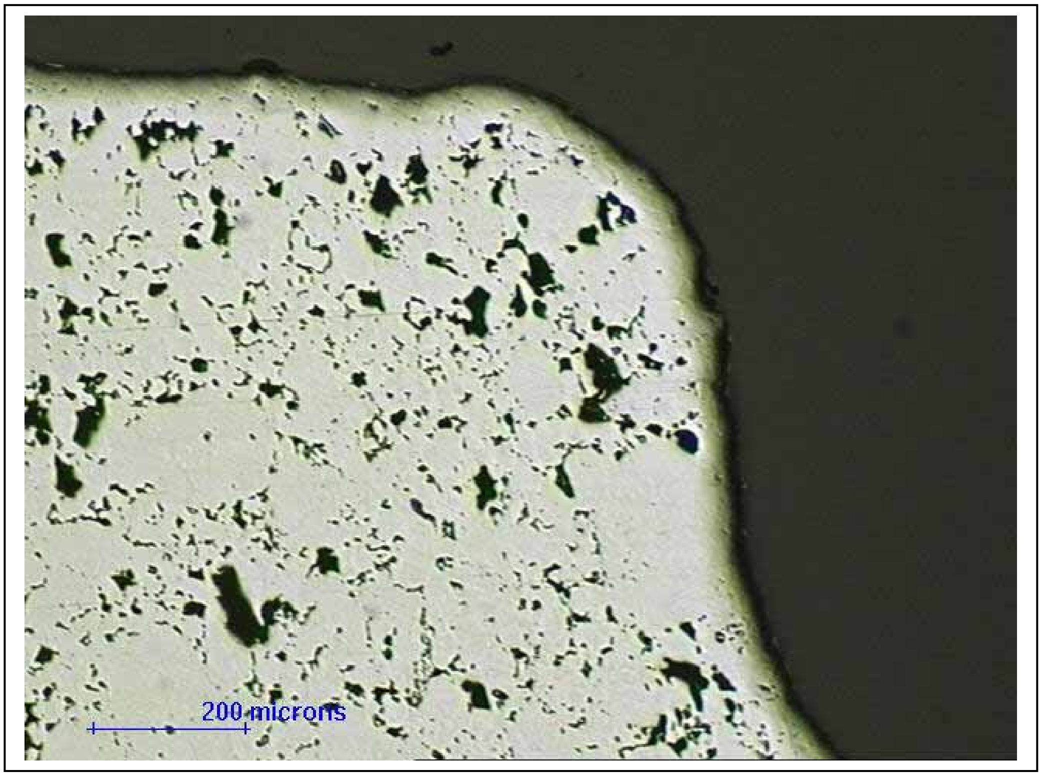


Fig. 25 Sintered steel after final polishing (traditional method), 50x

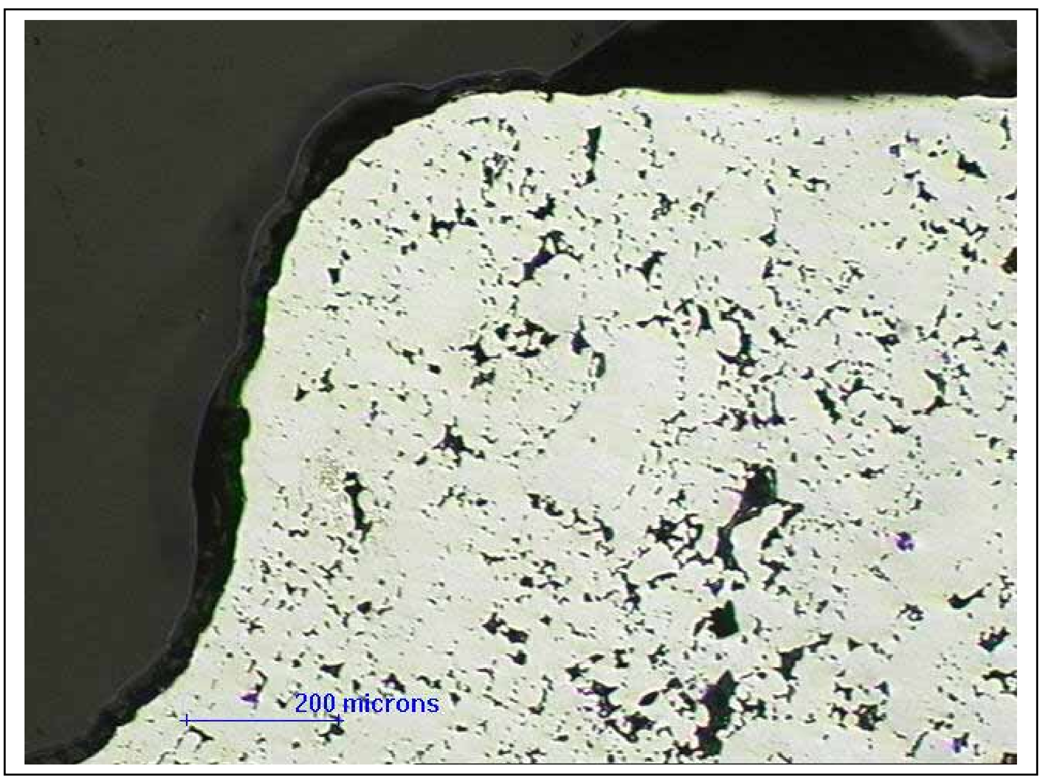


Fig. 26 Sintered steel after final polishing (Buehler's method), 50x

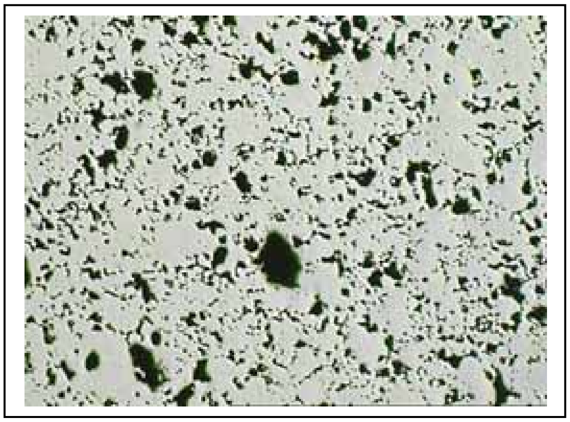


Fig.27a Grayscale image (Traditional method)

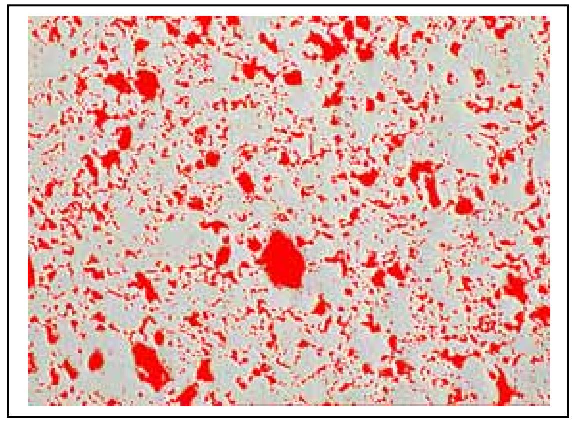
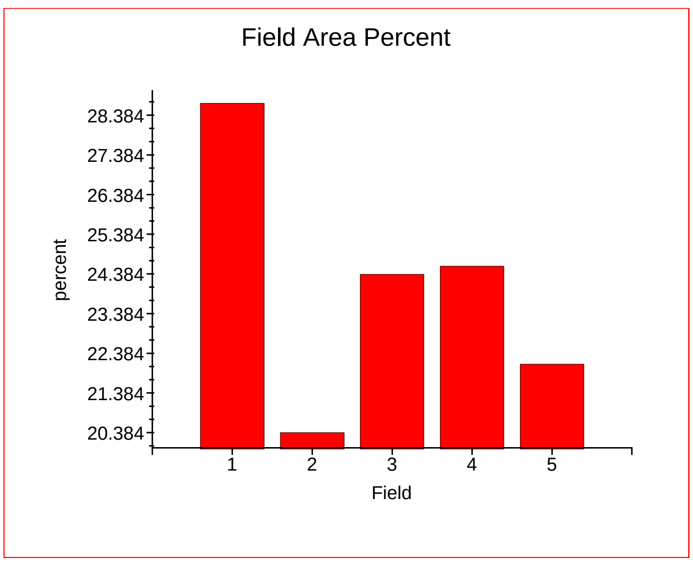


Fig. 27b Detected image (Traditional method)



Field Summary

Bitplane	Pore
Max:	28.6803 %
Min:	20.3838 %
Mean:	24.0232 %
Std Dev:	3.12395 %
Fld Area:	1.27947e+006 瘘
Tot Area:	6.39733e+006 瘘
Fld Count:	5
Over:	0
Under:	0

Fig.27 The image analysis result of the traditional sample preparation method on sintered steel.

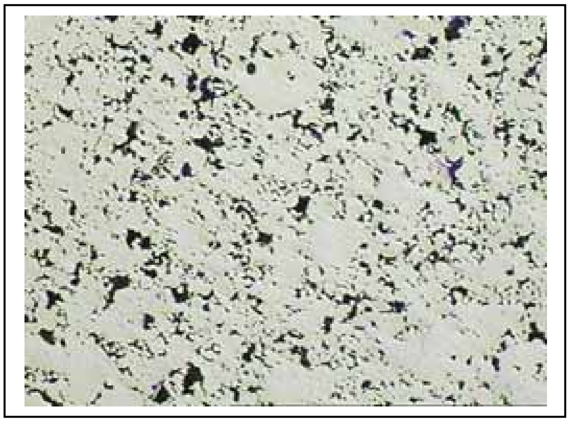


Fig.28a Grayscale image (Buehler's method)

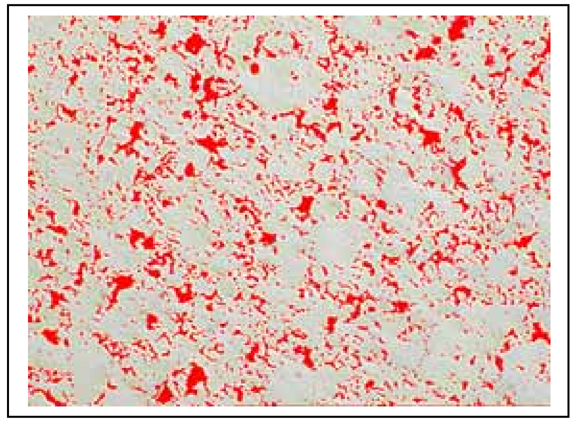
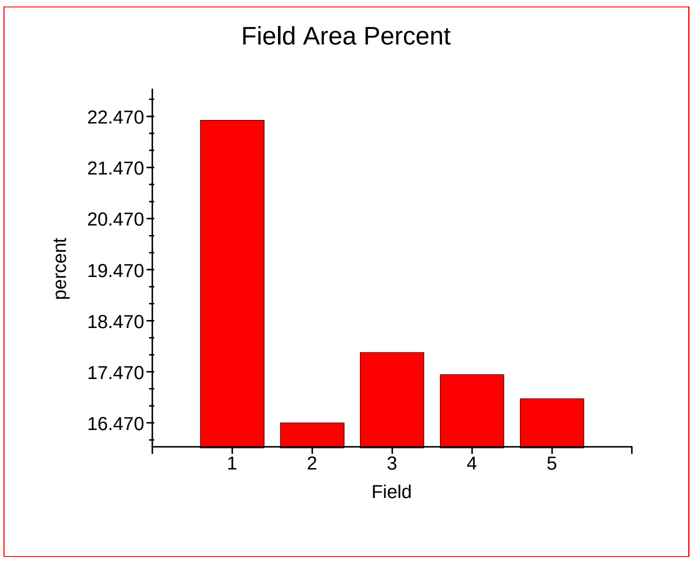


Fig. 28b Detected image (Buehler's method)



Field Summary

Bitplane	Pore
Max:	22.3923 %
Min:	16.4704 %
Mean:	18.2132 %
Std Dev:	2.39206 %
Fld Area:	1.27947e+006 疫
Tot Area:	6.39733e+006 疫
Fld Count:	5
Over:	0
Under:	0

Fig.28 The image analysis result of the Buehler's sample preparation method on sintered steel.