

Cutting Tools Files and a Microscope.

Many will have seen the cheap USB microscopes supplied by “*Traveler*” which are for sale in Aldi supermarkets. The construction is most inelegant and flimsy, but at a price of 35 Euro, it provides something that might be useful and could be cannibalised if necessary without any tears being shed. My main computer is about 5 years old now and runs Windows XP. I found that the software provided with the microscope was rather touchy and tended to crash the system, particularly if any changes were made to the default camera resolution or sampling rate. However, I could not cause the system to crash predictably, and sometimes I managed to set moderately high resolution. As well as offering static image capture, the microscope is capable of taking a video sequence, which is an attractive facility for viewing biological specimens.

My application was photographing small engineering components. The first photograph is of a worn brazed carbide tip lathe tool taken at 10 times magnification. Image resolution is 640 x 480 pixels, but if the software would behave, it should be possible to increase the resolution to 800 x 1200 pixels. I have cropped the image to the relevant part.

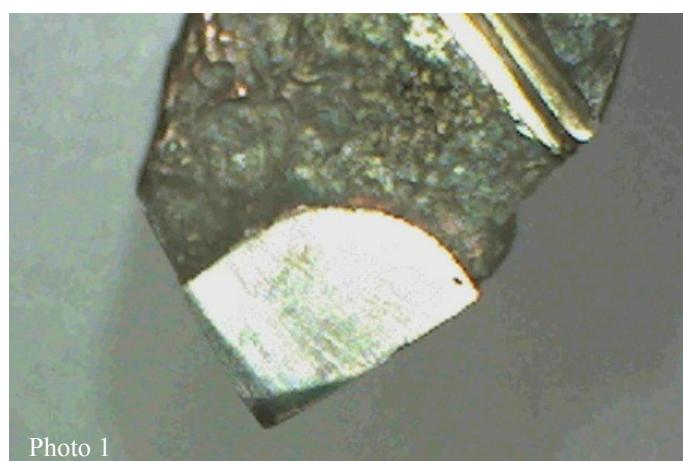


Photo 1

Lighting for the microscope is by LEDs, and the computer adjusts the image. Consequently the colour bears little resemblance to the appearance of the tip in natural light. The microscope has three magnification settings. At 60 times magnification, fracture on the face of the tip is clearly visible.

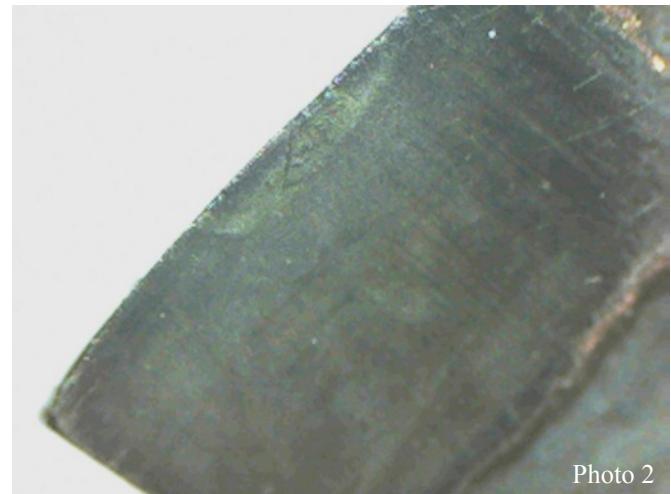


Photo 2

At the highest magnification of 200 times, the top of the cutting tool looks very sad indeed.

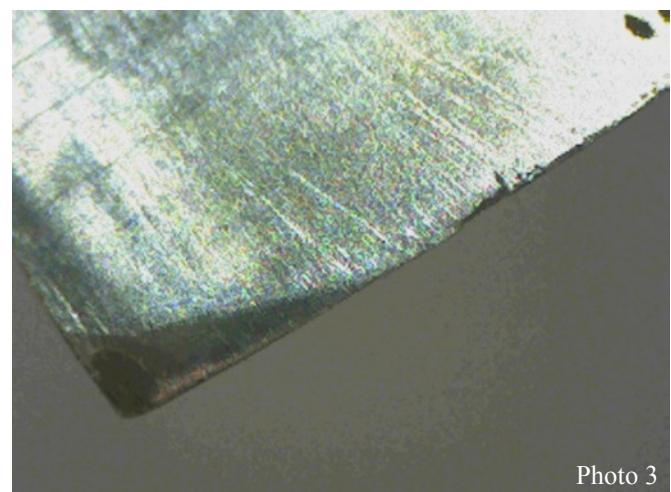


Photo 3

Notice that the tip wear shows darker. This is not due to any discolouration of the tool tip, but results from the lighting conditions. The cutting tool is a 3 dimensional surface and the worn edge is reflecting the incident light in directions other than the microscope lens. Consequently it appears darker.



Photo 4

To give an idea of the colour capability of the microscope, I have included the above picture of the Large Flowered Butterwort, as depicted on the current Irish 55c stamp. The black marks of the franking are

Irish 55c stamp. The black marks of the franking are clearly visible. One of the problems with the microscope is that its flimsiness can make focussing difficult.

I found the article about reconditioning files rather interesting. I was unaware that acid was used to improve the effectiveness of worn files. I decided to carry out a couple of experiments. I began by unearthing a very old and worn file. It was also solidly clogged with grime and filings. The first job was to give it a bit of a clean, so I looked around for a suitable piece of aluminium to use as a scraper.

There was none to hand, but I soon spotted an offcut of 1/2" copper pipe. I simply flattened one end of the pipe and discovered that I had made a very useful tool indeed.



Photo 5

The other end had been rounded by the action of the pipe cutter, so there were no sharp edges. However, I later made a plug for the end out of a piece of brass to smarten it up a bit.

The cleaning action of my new scraper was so effective that I forgot about what I had set out to do and started cleaning the dirt out of all the files I have in regular use. I soon discovered that the edge of the scraper wore according to the cut of the file. Effective cleaning action only took place once the edge had worn to match the file. A few more offcuts of copper pipe solved that issue with a different scraper assigned to each grade of file. I also found that a light brush with paraffin assisted the cleaning process.

I have included a general view of the tip of the file I used for my etching experiment after it had been cleaned with the copper scraper and prior to dipping.

Although the file had been cleaned up considerably, examination under the microscope at 10 times magnification, showed that there was a lot of residual debris in the crevices.



Photo 6

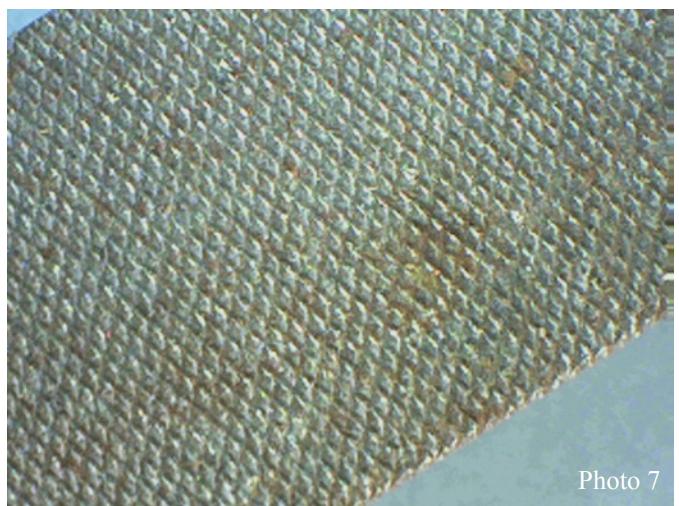


Photo 7

Magnification of 60 times shows the debris clearly. The cross cut pattern of the file is not as I had imagined it would be from textbook descriptions. The cuts running from left to right in the image are much deeper than those running from top to bottom. The image at 10 times magnification gave the impression that the cuts were of similar character, but the higher magnification reveals that this is not the case.

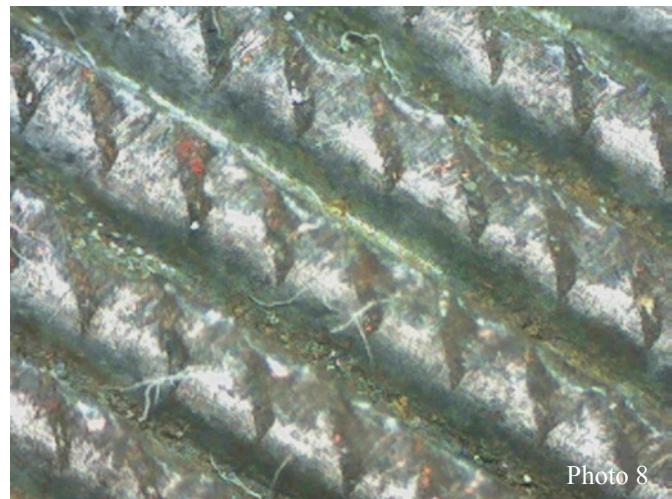


Photo 8

The pieces of fibre are likely to have come from the cloth used to wipe the file after cleaning. I suspect that the red coloured traces are pieces of copper from the scraper.

At this magnification, the depth of focus is not quite sufficient to provide a clear image of the tooth profile.

At the maximum magnification, it was not possible to get a really clear image. Contrast was markedly reduced. However, I was surprised that the loss of depth of field, already apparent at 60 times magnification, had not become so severe that it spoiled the image completely. It is possible that the image processing attempts to de-blurr the photograph and that loss of contrast is a by product of the de-blurring algorithm. I would be more comfortable if I knew exactly what the software was doing.

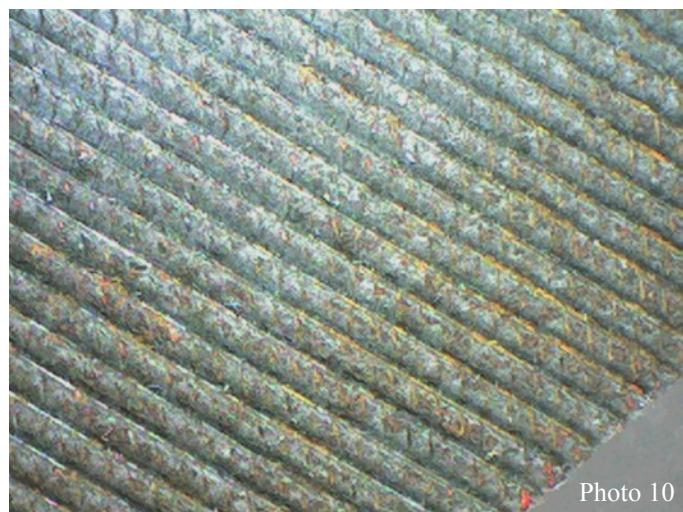


I was reminded of an incident from nearly 40 years ago. Stanley Orr, a friend of mine from day release college had found a new job in charge of the electron microscope in a local university department. Stan invited me to come and see his new toy. He had an early integrated circuit in the machine. After showing me the image at low magnification, Stan started cranking up the power. At each magnification, the part of the wafer he was imaging took on a different appearance. The effect was so dramatic that I felt compelled to ask "*But what does it actually look like?*" Stan was not the least bit perturbed by my question and replied: "*What do you want it to look like?*"

Although at the highest magnification there is no evidence of cutting teeth, the place where there might have been a single tooth when the file was new now presents a very ragged surface to the material being worked. The original channels criss crossed the teeth and still provide recesses into which the metal filings can flow.

In accordance with the articles I had read, I mixed up some Nitric acid and immersed part of the file in it to see what effect there would be. Experimental procedure was casual. I left the file in the acid for a few minutes and agitated it to persuade the acid to react.

The reaction was not vigorous and the main evidence that something had happened was the presence of a black granular sediment in the acid and discolouration of the file. After washing the file, there was a distinct difference between the feel of the part of the file which had not been etched and that part which had been immersed in the acid. The latter was definitely rougher to the touch. The photograph of the etched surface at 10 times magnification shows a distinctly matt appearance and the cross cutting is much less marked.



At 60 times magnification, it seems that any tooth form has been virtually destroyed. The polished surfaces visible in the photographs taken prior to etching have been similarly etched and this may be responsible for the sensation of increased roughness noted above.



At maximum magnification it can be seen that the tooth form has indeed been all but destroyed. However the extensive pitting may well be represent a more effective cutting surface, particularly since the height of the roughness is more uniform than the worn teeth.

The dullness of the images taken after etching is probably a consequence of the loss of reflectiveness which had been present prior to etching. This would reduce the natural contrast, it is anybody's guess how

the imaging software altered the raw data from the microscope.

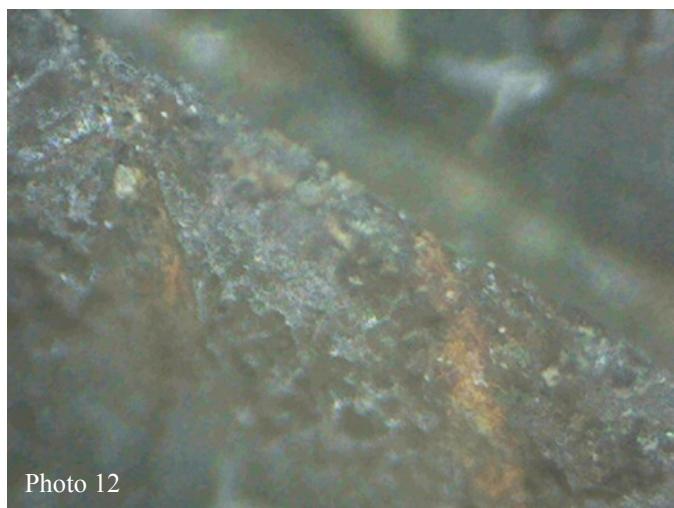


Photo 12

The orange coloured specks are possibly the remaining traces of copper from the scraper still lodged in the teeth. It is worth noting that the presence of the copper might have given rise to preferential etching through a dissimilar metal effect. Copper is lower in the electrochemical series than iron and should promote preferential corrosion of the iron.

Despite its limitations and bad habits, I have to say that I have been very pleased with the microscope. We even used a couple of the photographs produced from it to make greeting cards. Perhaps when I can afford a newer computer I will be able to use the maximum image resolution.

In any event the microscope has earned its keep many times over in assisting in the solution of one very subtle technical problem. For now at least, the microscope needn't fear the cannibal's screwdriver.

With the number of old worn files I have lying about, I was partly hoping that the etching approach would prove to be an effective rejuvenation technique, so in that sense I was a bit disappointed with the results.

However, the outcome of the experiment was satisfying inasmuch as I had been unable to think of any mechanism which would cause simple acid etching to produce an improved tooth form. I had expected that an exposed point such as a tooth would be eroded more dramatically than a flat surface, simply because the acid could act on the tooth from all sides.

In the event that seems to be what happens. In the light of this brief examination I would certainly not acid etch any new file. However, the finer and more even roughness produced by the etching may well be a useful treatment if an old rough file is to be assigned to finishing work.

Jim Cahill

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