A theory of how the WE diamond pastes work

Posted by mark76 - 01 Apr 2012 15:06

When I first saw Tom's microscope photographs of the edge of a knife after stropping with the 14 micron and 10 micron diamond pastes I was baffled. I was it again when I was able to repeat this myself. Even though the edge got very smooth and sharp, there were only tiny scratches caused by the pastes. How could pastes that were so little abrasive create such smooth edges, both on balsa and on leather?

I did some additional experiments and a bit of thinking. I think I now know why it was so difficult for me to comprehend how the diamond pastes work: I was trying to explain what I saw through the microscope in terms of assumptions I held about why stropping with the diamond compounds worked:

- Leather has a stiction that causes it to burnish the edge, i.e. smear out metal over a larger area that causes scratches to become less wide and less deep or sometimes even to disappear.
- The diamond pastes are abrasive because they remove metal by making lots of scratches with a width and a depth of their specified micron size (or a little lower, since only a part of every diamond particle would touch the edge).
- The diamond pastes work on leather due to the dual effects of burnishing and abrasion.
- The diamond pastes work on balsa due to abrasion.

Tom had already shown that the second assumption was likely not true. It dawned on me when I saw with my own eyes that the first assumption was not true either. The additional experiments and thinking showed that all four assumptions are wrong!

Yet these pastes do work. So I tried to come up with an alternative explanation. You can read it in full on my blog
. But in short I think the following is happening:

- Both the balsa and the leather strops are hardly abrasive by themselves. They do not cause much burnishing by themselves either.
- The strops become effective when loaded with the diamond pastes.
- The diamond pastes cause a lot of burnishing, but hardly any abrasion.

It is the pastes that do the work, not the strops. And these pastes are hardly abrasive, but have a strong burnishing power.

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Re: A theory of how the WE diamond pastes work
Posted by wickededge - 02 Apr 2012 16:47

Next I wanted to examine what happens when you go straight from the 1000 grit stones to a specific grit e.g. 1000 grit > 10 micron, 1000 grit > 3.5 micron and 1000 grit > 1 micron:

510x - 1000 grit diamond stones after 3.5 micron diamond and leather strops finish

510x - 10 micron diamond and leather strops after 1000 grit diamond stones

100 passes with the strops after the stones.

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Re: A theory of how the WE diamond pastes work
Posted by wickededge - 02 Apr 2012 16:50

After the 10 micron strops, I re-did the edge at 1000 grit diamond. Then jumped straight from the 1000 grit diamond to the 3.5 micron diamond and leather strops:

510x - 3.5 micron diamond and leather strops after 1000 grit diamond stones

100 passes with the strops after the stones.

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Re: A theory of how the WE diamond pastes work
Posted by wickededge - 02 Apr 2012 16:54

I again re-did the edge with the 1000 grit stones before skipping straight to the 1 micron diamonds and leather strops:

510x - 1 micron diamond and leather strops after 1000 grit diamond stones

100 passes with the strops after the stones.

I went on and did another 200 passes with the strops:

510x - 1 micron diamond and leather strops after 1000 grit diamond stones

300 passes with strops after the stones.

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Re: A theory of how the WE diamond pastes work

Posted by wickededge - 02 Apr 2012 17:02

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Next I wanted to see how the bevel turned out going incrementally but using the same number of passes as the direct 1000 grit to 1 micron test before, so I re-did the edge once more with the 1000 grit diamond stones and then did 100 strokes each with 10 micron, 3.5 micron and 1 micron diamond and leather strops for a total of 300 passes:

510x - 1000 grit diamond> 10 micron> 3.5 micron> 1 micron - 100 passes each

To compare, here again is the 1000 grit to 1 micron:

510x - 1000 grit diamond> 1 micron - 300 passes

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Re: A theory of how the WE diamond pastes work

Posted by wickededge - 02 Apr 2012 17:07

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I also took a couple of pictures by request:

510x - 1 micron with scale

510x - .5 micron with scale

This was a challenging set to take and I'll have to try again to get more contrast and visibility with the scratches.

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Re: A theory of how the WE diamond pastes work

Posted by mark76 - 03 Apr 2012 12:42

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Great pictures again, Clay. And a lot. You must have had a fun night
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How many strokes did you do with the polishing tapes? If you did a large number, the results surprise me as well. (Well, I almost get used to stuff not working as expected according to grit size.) You might get clearer results if you made scratches (almost) perpendicular to the scratches of the 1000 grit stones. Or did you do this already? (In which case I am not surprised, but flabbergasted
.)

wickededge wrote:

After getting the edge to 3.5 microns, I then went back to the polishing tapes:

510x - 3000 grit polishing tapes after 3.5 micron strops

510x - 7000 grit polishing tapes after 3000 grit tapes after 3.5 micron strops

I need to do a lot more work playing with the polishing tapes!

Yes, you cannot write them off that quickly. But this doesn't look encouraging. The scratch pattern is… well, it'd hardly call it a pattern
. I think you need a set of somewhat even and repetitive scratches for the tapes to be abrasive in an effective manner.

wickededge wrote:

Now on to 1 micron diamond and leather after the 3.5 micron diamond and leather:

510x - 1 micron diamond and leather strops after 3.5 micron diamond and leather

Looking good!

That is definitely looking good! Which 1 micron compound did you use?

I find these two pictures very interesting:

Then jumped straight from the 1000 grit diamond to the 3.5 micron diamond and leather strops:

510x - 3.5 micron diamond and leather strops after 1000 grit diamond stones

100 passes with the strops after the stones.

I again re-did the edge with the 1000 grit stones before skipping straight to the 1 micron diamonds and leather strops:

510x - 1 micron diamond and leather strops after 1000 grit diamond stones

100 passes with the strops after the stones.

It seems the 3.5 micron compound causes a little more burnishing than the 1 micron compound. Not a

lot, since 200 stropping strokes with the 1 micron diamond compound seem to create a better result than 100 strokes with the 3.5 micron compound. But still, the stiction is different.

wickededge wrote:

I also took a couple of pictures by request:

510x - 1 micron with scale

510x - .5 micron with scale

This was a challenging set to take and I'll have to try again to get more contrast and visibility with the scratches.

Thanks a lot.
. I am working on the scratch sizes as you might have seen. When I make pictures like these myself, one where the edge is almost white and another one in which the edge is quite dark, I find it very difficult to compare them. The scratches also seem different. How do you deal with this (other than by making the photographs again)?

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Re: A theory of how the WE diamond pastes work
Posted by wickededge - 03 Apr 2012 13:03

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I'm definitely going to redo the lapping film tests, starting from a polished edge and count strokes and possibly alternating stroke directions, maybe from polished down through 7k to 3k and then back up. I rotated the scope to get the dark and light images in an effort to see the scratches better but wasn't very satisfied with darker image, have to keep experimenting with it. As far as the 'stiction' of the different strops goes, I think it might be a function of how much paste is on the surface and how much moisture it has.

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Re: A theory of how the WE diamond pastes work
Posted by razoredgeknives - 03 Apr 2012 13:37

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Whoa! New scope Clay? Nice pics... what is it?

WOW! Those are some interesting photos and observations Clay! It would seem that there is no sense in going 10>5>3.5>1 when you get the same, if not better results with just going straight to the 1m! Is this observation correct?

wickededge wrote:

Next I wanted to see how the bevel turned out going incrementally but using the same number of passes as the direct 1000 grit to 1 micron test before, so I re-did the edge once more with the 1000 grit diamond stones and then did 100 strokes each with 10 micron, 3.5 micron and 1 micron diamond and leather strops for a total of 300 passes:

510x - 1000 grit diamond> 10 micron> 3.5 micron> 1 micron - 100 passes each

To compare, here again is the 1000 grit to 1 micron:

510x - 1000 grit diamond> 1 micron - 300 passes

Also, it seems as if, when you started w/ the 1k grit and on you weren't really hitting all the way to the edge of the edge, am I right?

BTW, Clay, which knife is that a pic of? I am curious as to how hard that Aus 8 steel is on the HRC scale...

Thanks for checking on the lapping film... still curious as to what your further testing will reveal

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Re: A theory of how the WE diamond pastes work
Posted by wickededge - 03 Apr 2012 13:46

That's a good question and I'm not sure I've discovered an answer yet. I'd like to do a lot more testing because I don't think I controlled the experiment enough. I think I need to at least repeat it but perform the exact number of strokes with the 1000 grit stones. I think I may not have done enough strokes with them when I rebuilt the bevel each time which could be skewing the results. You can see in the first 1000 grit picture that I didn't do enough strokes to reach the edge, so I'll repeat and see how it turns out. I'll also need to control for age of strops and amount of paste applied.

The new scope is the Dino-Lite AM-413T5. I'm really liking it so far!

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Re: A theory of how the WE diamond pastes work
Posted by mark76 - 03 Apr 2012 15:28

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wickededge wrote:

As far as the 'stiction' of the different strops goes, I think it might be a function of how much paste is on the surface and how much moisture it has.

That is a good one. In my experiences the leather strops usually work a little better than the balsa strops for burnishing. However, I had one case in which the balsa worked better. That might be the reason.

I tried, by the way, to increase the stiction of a leather strop by making it wet. Not the slightest effect. Next up is stropping with chewing gum on balsa
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