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 - 11 Apr 2012 14:40

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mark76 wrote:

That 1 micron diamond paste after the 10K Choseras makes a smooth edge…

Agreed!

mark76 wrote:

And then it is weird that the .5 micron paste seems to make scratches again.

I think there is an issue with my .5um strops - I had previously scraped the surface to clean them off and gave it a suede or split grain texture. I'll have to replace the leather on that set.

mark76 wrote:

The results with split horse leather are strange. The .25 micron stuff on split horse leather seems to make even wider scratches than the .5 micron stuff. But then the .125 stuff seems to smoothen the edge again… Could it be the lighting? Or contamination?

Switching from cow leather to horse, top to split and back is creating a lot of confusion - I'll need to redo this series with all cow/top leather, all horse/split and all horse/top leather. Additionally, Ken is sending me a bunch of nano-cloth strops so we can compare pure abrasive 🙂

mark76 wrote:

What strikes me is that the .125 scratches seem much more apparent after the top horse leather than after the split horse leather. But after the cow leather they are hardly visible. Lighting? Or are we running into the limitations of the microscope?

I've done a similar series before but with alternating stroke directions which were clearly visible, so I think that we're not having issues with the equipment. The lighting for each shot is identical; I'm using a template for placing the blade. My guess is that it's amount of abrasive present on the substrate.

mark76 wrote:

Your post does seem to show that the smoothest edge is not necessarily the sharpest (also not for push cutting or the HHT). Or do I interpret things wrongly?

I agree about the HHT. The push cutting through paper was so similar between grits that it is hard to tell when one is better. The 1600# ceramic and the 5k Chosera created some fraying, the rest were virtually identical.

mark76 wrote:

I'd be interested to see what that plain top horse butt leather does to a completely clean edge, compared to plain top cow leather. Some straight razor honers like top horse leather because it apparently has silicates in it already by itself. And your first HHT pass was after the top horse leather.

This would be a very fun test to conduct. I'll work on getting the edge as clean as possible and the re-testing the plain cow and horse leathers.

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Re: A theory of how the WE diamond pastes work

Posted by wickededge - 11 Apr 2012 17:22

Okay, I just got my mind blown and now I'll share; Ken sent me some kangaroo leather for strops along with some nano-cloth. Here is a nice progression going from 1um Diamond on Cow Leather (Top) to .25 Diamond on Kangaroo Leather (Top) to .125 CBN on Nano-Cloth:

1um Diamond and Cow Leather (Top) - 100 strokes

.25um Diamond on Kangaroo Leather (Top) - 100 strokes

.125um CBN on Nano-Cloth - 100 strokes

Totally cool!!!

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Re: A theory of how the WE diamond pastes work

Posted by wickededge - 11 Apr 2012 17:29

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I can clearly see that with the Kangaroo Leather and Nano-Cloth strops, combined with the finer compounds, I've effectively reached the limit of what I can image with my equipment. I've spent the last 1/2 hour trying to tinker with the scope and lighting to see some scratches and just can't. I can move the blade around and see stuff that I didn't polish out, but for scratches created in the last progression, I can't see any at all. I'm really excited, thanks Ken! We'll be adding the Roo strops and nano-cloths soon and I'll be in the market for a higher magnification scope!

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Re: A theory of how the WE diamond pastes work

Posted by wickededge - 11 Apr 2012 17:30

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As much as I hate to put scratches on such a perfect edge, I'm going to now clean my 10k Choseras really well and see what kind of scratch pattern I get.

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Re: A theory of how the WE diamond pastes work

Posted by wickededge - 11 Apr 2012 17:48

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Okay - bit the bullet and re-created the 10k scratch pattern following a second iteration of the .25um Diamond and Kangaroo Leather strops. As always, there is a slight bit of convex shaping that occurs with the leather, so you see the new scratches from the 10k stone come in but not making quite to the very edge because of the last bit of curvature - shows a nice distinction between the media:

.25um Diamond on Kangaroo Leather (Top) - 100 strokes

10k Chosera - 200 strokes

For reference, the little band of super polished edge is only 31um wide.

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Re: A theory of how the WE diamond pastes work
Posted by wickededge - 11 Apr 2012 18:02

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and just for grins...:

10k Chosera - 100 strokes with human hair

.25um Diamond and Kangaroo Leather (Top) - 100 strokes

After the 10k Choseras, I went back and did a quick 100 strokes with the .25um Diamond and Roo strops to see how quickly I'd get a result - pretty quick!

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Re: A theory of how the WE diamond pastes work
Posted by holymolar - 11 Apr 2012 20:20

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WOW!

I want those Kangaroo Leather and Nano-Cloth strops ASAP.

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Re: A theory of how the WE diamond pastes work
Posted by wickededge - 11 Apr 2012 20:29

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holymolar wrote:

WOW!

I want those Kangaroo Leather and Nano-Cloth strops ASAP.

We'll be listing them on the site this week.

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Re: A theory of how the WE diamond pastes work

Posted by mark76 - 12 Apr 2012 02:00

This is totally cool!
WOW! Finally the submicron compounds do work.

wickededge wrote:

We'll be listing them on the site this week.

And maybe work some overtime to process orders...

It seems like the substrate is much more important than I (we?) thought. That roo and nanocloth must be supersmooth. For that reason I'm still very interested in the top grain horse leather pictures...

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Re: A theory of how the WE diamond pastes work

Posted by jendeindustries - 12 Apr 2012 02:42

Holy Day-am!!!! That Kangaroo and Nanocloth wins first place!!!!

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