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 10:06

Onward with the studies

The next five images are very interesting; I went back to the 1600# ceramic and recreated the scratch pattern, then went to the 3.5um Diamond and Leather strops with the following sequence: 50 strokes/side> 100 strokes/side> 150 strokes/side> 200 strokes/side:

1600# Ceramics

3.5um - 50 strokes

3.5um - 100 strokes

More to come...

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Re: A theory of how the WE diamond pastes work

Posted by wickededge - 11 Apr 2012 10:09

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and onward:

3.5um - 150 strokes

3.5um - 200

The 1600# ceramics took a little chunk out of the edge and it's easy to track through the pictures exactly how the strops are working on the surface and edge.

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Re: A theory of how the WE diamond pastes work

Posted by wickededge - 11 Apr 2012 12:33

Time for curveballs! I wanted to test cutting performance and I wanted to add in the 5k and 10k Choseras to the mix, so I reestablished the 1600# scratch pattern from the ceramic stones:

1600# Ceramics

Then I used the 5k Choseras:

5k Choseras - 100 strokes

I wasn't quite hitting the edge, so I did another 100 strokes:

5k Choseras - 200 strokes

Next batch will be the 10k Choseras.

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Re: A theory of how the WE diamond pastes work

Posted by wickededge - 11 Apr 2012 12:39

On to the 10k Choseras:

10k Choseras - 100 strokes The edge is interesting here...

From the 10k stones, I went on to the strops, first the 1 micron Diamond on Balsa strops:

1um Diamond on Balsa Strops - 100 strokes

.5um Diamond on Balsa Strops - 100 strokes

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Re: A theory of how the WE diamond pastes work

Posted by wickededge - 11 Apr 2012 12:44

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On to the small stuff, it gets weird from here...

.25um CBN on Horsebutt (Split) - 100 strokes

.125um CBN on Horsebutt (Split) - 100 strokes

.125um CBN on Horsebutt (Top) - 100 Strokes

more to come....

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Re: A theory of how the WE diamond pastes work

Posted by wickededge - 11 Apr 2012 12:49

Continuing weirdness:

Plain Horsebutt Leather (Top) - 100 strokes

.5um Diamond on Cow Leather (Top) - 100 strokes

I wish I'd cleaned the blade for this photo....

Plain Cow Leather (Top) - 100 strokes

and finally

.125um CBN on Cow Leather (Top) - 100 strokes

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Re: A theory of how the WE diamond pastes work

Posted by PhilipPasteur - 11 Apr 2012 12:55

Interesting...

First, thanks Clay for all of this! it is real nice to be able to see what is happening with these progressions.

The 10K Chosera edge is interesting because it seems to be non-uniform or maybe a bit uneven.Not sure how to describe it. Curious, so far I have liked the edge that this stone leaves. Though I must say that I have almost always gone to the leather strops at 1 micron diamond and .5 micron CBN after the

10K.

It it my imagination or is the 1 micron diamond bevel showing fewer scratches than the 0.5 micron bevel.

At this magnification it seems hard to tell which "edge of the edge" is better, but I am leaning towards the 1 micron edge.

I wish that I could get photos that are even close to the quality that you obtain.

What do others think?

Phil

BTW, just saw the last photos. It looks like the horse butt is some abrasive stuff. Interesting that there are all kinds of stories out there on the razor forums about how superior it is to other stropping media!

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Re: A theory of how the WE diamond pastes work

Posted by wickededge - 11 Apr 2012 13:03

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For each stage in the latest progression, I repeated the same tests - hanging hair test (HHT) and copy paper push cut (CPPC). Below are the results, in order of the progressions:

Medium	HHT	CPPC
1600# Ceramic	Fail	Pass, slight fraying of the edges
5k Chosera	Fail	Pass, slight fraying of the edges
10k Chosera	Fail	Pass, very smooth cut
1um Diamond on Balsa	Fail	Pass, very smooth cut
.5um Diamond on Balsa	Fail	Pass, very smooth cut
.25um Diamond on Horsebutt	Fail (Split)	Pass, very smooth cut
.125um Diamond on Horsebutt	Fail (Split)	Pass, very smooth cut
Plain Horsebutt (Top)	Pass	Pass, very smooth cut
.5um Diamond on Cow Leather	Pass (Top)	Pass, very smooth cut
Plain Cow Leather (Top)	Pass	Pass, very smooth cut
.125um CBN on Cow Leather	Pass (Top)	Pass, very smooth cut

I was surprised by these results, especially how well the plain top leather, both cow and horsebutt did with the hanging hair test, even more so considering the difference in scratches.

What *I think* I've learned so far from this exercise (and from regular usage) is that there is a lot to be said for the common (on this forum anyway) wisdom about applying different finishes for different usages e.g. the super smooth finishes that we get from the strops are not ideal for when I'm butchering meat, specifically all the very fine work of trimming silverskin and connective tissue - for that, a finish of 3k or 5k really works the best. Clearly if I want to cut hanging hairs, I need to finish with plain leather. It's almost mind boggling (but loads of fun!)

I'm a little concerned about the 10k image and I'll need to redo that one to rule out poor technique and/or surface contaminants. I'll wash the stones well and give it another run, starting with a super smooth finish.

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Re: A theory of how the WE diamond pastes work

Posted by mark76 - 11 Apr 2012 13:34

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Wooh! That is a great series. And cutting tests as well.

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

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

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?

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?

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'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.

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Re: A theory of how the WE diamond pastes work

Posted by wickededge - 11 Apr 2012 14:27

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PhilipPasteur wrote:

Interesting...

First, thanks Clay for all of this! it is real nice to be able to see what is happening with these progressions.

You're welcome, these are very fun to do.

PhilipPasteur wrote:

The 10K Chosera edge is interesting because it seems to be non-uniform or maybe a bit uneven.Not sure how to describe it. Curious, so far I have liked the edge that this stone leaves. Though I must say that I have almost always gone to the leather strops at 1 micron diamond and .5 micron CBN after the 10K.

I need to repeat the 10k stone because I think there might have been surface contamination or some other issue; most likely the stones picked up some grit from being stored with the rest of my Choseras.

PhilipPasteur wrote:

It it my imagination or is the 1 micron diamond bevel showing fewer scratches than the 0.5 micron bevel.

At this magnification it seems hard to tell which "edge of the edge" is better, but I am leaning towards the 1 micron edge.

I agree that the .5um seems coarser than the 1um. I had almost identical results previously as well and it may be an issue with my strops. I had scraped off the surface of my .5um strops resulting in an almost suede surface which might be responsible. I'll have to replace the leather on that set.

PhilipPasteur wrote:

BTW, just saw the last photos. It looks like the horse butt is some abrasive stuff. Interesting that there

are all kinds of stories out there on the razor forums about how superior it is to other stropping media!

The horse butt is clearly very abrasive. It's interesting that the plain, top grain horse butt was one of the only ones to pass the hanging hair test - obviously the edge it produces excels at cutting hair.

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