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 - 09 Apr 2012 11:44

The biggest challenge is examining the effects of those finer grits because our imaging doesn't get that fine. If we can get to >1000x we might be able to do a little better. If we're trying to get below .1 microns, then we're going to need access to much better imagining.... I'll post some pics a little later this morning of the edge with a variety of grits.

mark76 wrote:

Thanks a lot, Tom! Of course stones work like that! I should have made that up myself, but somehow I didn't. (Which reminds me of a quote of my old professor, who said that the best articles are the ones that seem so simple you wonder why they were written.)

With your explanation of host and guest scratches, I think I can also make a bit more sense of some stropping spray progressions I read about on your blog. (But only a bit 🙂
.) For example, you stropped your Spyderco Military with 0.25 micron spray and then with 0.05 micron spray. It seems the difference between 0.25 and 0.05 (factor 5) is too much to be able to wipe out the 0.25 scratches. Did you try to create 0.05 micron guest scratches on top of 0.25 micron host scratches?

If so, I understand that makes the edge sharper. However, wouldn't the edge get even sharper if you did try to wipe out some of the 0.25 micron scratches, for example with 0.125 micron spray, then 1 and then 0.05 micron spray? Or do things work differently in the submicron rabbit hole?

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Re: A theory of how the WE diamond pastes work

Posted by mark76 - 09 Apr 2012 12:00

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wickededge wrote:

The biggest challenge is examining the effects of those finer grits because our imaging doesn't get that fine. If we can get to >1000x we might be able to do a little better. If we're trying to get below .1 microns, then we're going to need access to much better imagining....

Very true. However, if it works (I assume Tom and others do sensible things), it'd be interesting to know how it works at least in theory.

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Re: A theory of how the WE diamond pastes work

Posted by jendeindustries - 09 Apr 2012 19:36

It's true - I really can't determine much of a scratch pattern past 30K or .5 microns on any of the equipment I have.

However, the edge of the edge starts to really become a point, and if you do too much, you begin to see the edge of the edge begin to fray from structurally being too thin.

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Re: A theory of how the WE diamond pastes work

Posted by mark76 - 10 Apr 2012 14:58

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jendeindustries wrote:

It's true - I really can't determine much of a scratch pattern past 30K or .5 microns on any of the equipment I have.

OK, then I'll stay in the area of multiple microns

I made a new blog post, on stropping with the 14 micron paste after the 1600 grit stones. With today's knowledge the results won't surprise: it works beautifully. However, two weeks ago, I would be baffled.

And even now I am surprised by how effective the paste is. Only 50 strokes were required to obtain a very smooth edge. The 200 more I did were really not necessary.

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Re: A theory of how the WE diamond pastes work

Posted by wickededge - 10 Apr 2012 15:03

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mark76 wrote:

Only 50 strokes were required to obtain a very smooth edge. The 200 more I did were really not necessary.

I guess the next step would to see how many exactly. Maybe going from the 1000# diamonds or the 1600# ceramics and only doing 10 strokes before imagining.

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Re: A theory of how the WE diamond pastes work

Posted by mark76 - 10 Apr 2012 15:18

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wickededge wrote:

I guess the next step would to see how many exactly. Maybe going from the 1000# diamonds or the 1600# ceramics and only doing 10 strokes before imagining.

That is a good one. There is a noticeable difference, however, between using the strops after the 1000 grit stones and using them after the 1600 grit stones. They nicely smoothed out the 1000 grit scratches, but these scratches were still well visible. However, when used after the 1600 grit stones, the 1600 grit scratches nearly got wiped out.

I am starting to wonder whether the WE paste loaded strops are perhaps the ideal means to prevent the "overhoning effect" (coarse sratches becoming apparent only when sharpening with fine stones) that Tom has described. I.e. do some stropping after the 1600 grit stones before going to the high grit Choseras or Shaptons.

I know it sounds weird, but this topic has surprised me before... What do you think?

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Re: A theory of how the WE diamond pastes work

Posted by wickededge - 10 Apr 2012 15:24

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mark76 wrote:

I.e. do some stropping after the 1600 grit stones before going to the high grit Choseras or Shaptons.

That's an interesting thought. I sometimes do something similar when I'm studying grits; I polish and smooth the edge until it's near perfect, then go straight to the grit I want to study so I'm sure that what I'm seeing is exactly the grit in question.

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Re: A theory of how the WE diamond pastes work

Posted by wickededge - 10 Apr 2012 15:55

Okay, for fun, I decided to do a preliminary study of stroke numbers with the strops,using the 14um diamond pastes right after the 1600 ceramic stones. I did 10 strokes per side before taking each picture:

1600# Ceramics

14um - 10 strokes

14um 20 strokes

more to come...

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Re: A theory of how the WE diamond pastes work

Posted by wickededge - 10 Apr 2012 15:56

14um - 30 strokes

14um- 40 strokes

14um - 50 strokes

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Re: A theory of how the WE diamond pastes work

Posted by mark76 - 10 Apr 2012 16:04

This is what we call fast and furious, Clay!

I just realized I made an error in my description of the blog post: the smoothing out of the scratches appeared after a 100 strokes, not 50. And with the 5 micron paste after the 1600 grit stones (a previous blog post) I could still see improvement after 250 strokes, likely due to the better lighting.

But your results will be much more conclusive: not only more pictures, but also a better picture quality and great lighting.

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