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 - 01 Apr 2012 15:40

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mark76 wrote:

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Mark,

This is really well, done, thanks for the contribution. I really enjoyed reading the whole write-up on your blog. I agree that the compound itself is a considerable factor in the burnishing effect we see. I went back through a progression from a couple of weeks ago (grit progressions) to examine the various pastes and the scratches of various grits are clearly visible in the ascending/descending progressions.

Your theory seems very sound - the substrate plus paste provides enough 'stiction' to burnish which is further aided by the abrasive in the paste. The abrasive itself has an effect but is much less, grit for grit than if it were synthesized into a stone.

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Re: A theory of how the WE diamond pastes work

Posted by mark76 - 02 Apr 2012 11:58

Thanks for you kind words, Clay!

I took a look at your photographs again and they are better than mine. You can see the scratches left by the 14-10-5-3.5 micron pastes more clearly. In my photographs (still to be posted) I was not able to see any scratches caused by the 3.5 micron paste (probably because I could not get the lighting right).

I was thinking whether it would be possible to measure the scratch size (which abrasion is ultimately about; it is not the size of the diamonds that determines the abrasiveness of a stropping compound, but the size of the results they produce). I already saw you have software with which you can draw lines with a particular length in microns. Suppose you drew a line of, say, 20 or 30 microns long perpendicular to the scratches. If you then magnify this portion of the photograph, we can perhaps count the number of scratches per 10 (or 20 or ...) microns and work out the scratch size in that way.

That would not only give an indication of the relative abrasiveness of the stropping compounds, but could perhaps also allow us to compare the abrasiveness of the stones to the abrasiveness of the stropping compounds (since the grits comparison chart appears not to be very useful for that purpose).

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Re: A theory of how the WE diamond pastes work

Posted by LukasPop - 02 Apr 2012 12:31

Interesting theory Mark. Pictures of edges after stropping seemed confusing to me also, they were just too smooth regarding the size of diamond particles. So it looks to me like one size of diamond particles on strops are sufficient, and this size is quite irrelevant.

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Re: A theory of how the WE diamond pastes work

Posted by wickededge - 02 Apr 2012 14:30

LukasPop wrote:

Interesting theory Mark. Pictures of edges after stropping seemed confusing to me also, they were just too smooth regarding the size of diamond particles. So it looks to me like one size of diamond particles on strops are sufficient, and this size is quite irrelevant.

This gives me a nice idea for an easy experiment:

1000# > 10 micron strops

1000# > 3.5 micron strops

1000# > 1 micron strops

I'll embark on that next!

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Re: A theory of how the WE diamond pastes work

Posted by wickededge - 02 Apr 2012 16:07

Okay, long fun day of experimenting with the sharpener and various grits. Today I mostly worked on the following: 1000# diamond stones, 14, 10, 5, 3.5, 1 and .5 micron diamonds on leather and some on balsa. Since there were so many different progressions, I'll break it up into a variety of posts, starting with a 1000 grit diamond stone finish:

510x

Next I went to 3000 grit polishing tape:

510x

And then 7000 grit polishing tape:

510x

I was really surprised at the results of the polishing tapes, I expected a much finer finish. This is an experiment that I'll have to do again, starting from an already polished edge. One thing that jumps out at me right off is that when I repeat this, I'll need to spend a lot more time than I'd anticipated with the tapes - they don't remove scratches nearly as quickly as I had assumed.

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Re: A theory of how the WE diamond pastes work

Posted by wickededge - 02 Apr 2012 16:16

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Next I stropped the blade with 10 micron diamonds on leather and then 3.5 micron diamonds on leather:

510x - 10 micron diamonds on leather after 7000 grit polishing tape

510x - 3.5 micron diamonds on leather sequence= 7000 tape> 10 micron strops> 3.5 micron strops

The diamond paste and leather strops made a big difference quickly.

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Re: A theory of how the WE diamond pastes work

Posted by wickededge - 02 Apr 2012 16:20

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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!

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Re: A theory of how the WE diamond pastes work

Posted by wickededge - 02 Apr 2012 16:29

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Next I decided to try 3.5 micron balsa strops to compare with the 3.5 micron leather strops:

I first went to the 3.5 micron balsa strops right after the 7000 grit tapes

510x - 3.5 micron diamond and balsa strops after 7000 grit polishing tapes

Then I went to the 3.5 micron leather strops right after the 3.5 micron balsa strops

510x - 3.5 micron leather strops after 3.5 micron balsa strops

Then I went back to the 3.5 balsa strops

510x - 3.5 micron balsa strops after 3.5 micron leather strops - 2nd pass

Then back to the 3.5 leather strops

510x - 3.5 micron leather strops after 3.5 micron balsa strops - 2nd pass

It looks like there is a clear difference in finish between balsa and leather.

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Re: A theory of how the WE diamond pastes work

Posted by wickededge - 02 Apr 2012 16:33

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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!

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