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 cbwx34 - 30 Oct 2012 20:32

PhilipPasteur wrote:

I noticed in your first pic of the edge at 50 grit that there are some places where the metal looks like it has been burnished in small areas as evidenced by the smoothing of some areas. I am going to see if I can copy the pics and circle the areas... I am not a computer graphics wiz...and the forum does not let me copy the pics.

Here's the links to the 50g pictures...

wickededgeusa.com/media/kunena/attachments/52/50-Grit.jpg

wickededgeusa.com/media/kunena/attachmen...BN-after-50-Grit.jpg

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Re: A theory of how the WE diamond pastes work
Posted by PhilipPasteur - 30 Oct 2012 20:32

One other thought about an experiment. If we want to look at simply burnishing as a property of stropping itself, why not try some Kangaroo or Nanocloth with no abrasive. If we are talking local pressure with the strop, would you not still see it with materials that have minimal (nonocloth supposedly almost none) abrasive properties of there own.

Not sure how to duplicate the stiction... perhaps just the right amount of water or alcohol.

In any case, this might be a sort of "control" scenario. It may help to isolate whether any burnishing that may be happening is due to the strops or the abrasives, or maybe the combination.

Phil

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Re: A theory of how the WE diamond pastes work
Posted by wickededge - 30 Oct 2012 21:09

Hey Phil,

Thank you for all your thoughts. I really appreciate your balanced skepticism and I agree that the idea that leather can burnish the metal defies intuition. Still, I've seen *some* effect that *looks* like burnishing so often that I haven't been able to come up with a more competitive theory. At the moment, I'm speculating that the 'stiction' is able to apply enough pressure locally that it can move some small amounts of metal around. It is remarkable how much drag I'm able to create with the strops; so much so that they will actually lift up my granite base. I will try some blank strops, that's definitely on the list though in the past, when using water, I haven't been able to duplicate the 'stiction'. I might do better with alcohol, that seems to work very well. I've also got some plain paste on order from our supplier so I can experiment with the effect without the abrasives in the equation. Eventually, I'll get the project with Sandia Labs and their SEM done and we might have a more definitive answer.

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Re: A theory of how the WE diamond pastes work
Posted by PhilipPasteur - 30 Oct 2012 22:34

I was thinking that.. at one time, I could do the calcs. Find actual yeild strenght numbers and look at what kind of pressures might be applied through the leather. This would give us a good idea if it is even physically possible to burnish with the entire contact area. Of course the local pressures at the top of the scratch peaks may be impossible to calculate without some serious programing... which is beyond the time I have to actually do. I am at a loss as to how various levels of stiction could be calculated though. Time to go back to the books. I have some vintage 1968 Materials properties texts...
I was once even pretty good with the Calculus... once.

I also wonder, after reading what you said, if I, with my technique, would ever see the effect. As I mentioned before, I have looked for the amount of compound on the leather with alomost zero moisture content (relative humidity here often in the single digits...but almost always quite under 40% that give me the lowest amount of friction, hence stiction I guess ...using very very light strokes... with the calculated intent of simply letting the abrasive do its work. Perhaps this might also be why I can see very little convexing of the shoulders of the edge at 400X as well.

If I was lifting my 16 pound marble base when stropping ... I would figure out how to stop it from happening...

Thanks Curtis for the links... I have a sick server that I am working on tonight...maybe I can get

something done on this tomorrow...

Phil

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Re: A theory of how the WE diamond pastes work
Posted by FredHermann - 31 Oct 2012 08:47

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So after my head was done pounding reading this, following all the associated links, and marveling at the pretty pictures...one thing stands out.

Clay, how much pressure are you using when stropping? I *have* to assume you use equal pressure thru the process, but how much? I saw mention of lifting the base edge when stropping, which implies lots of pressure....

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Re: A theory of how the WE diamond pastes work
Posted by PhilipPasteur - 31 Oct 2012 08:55

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I guess I was trying to hint at the same question. Considering the repeated advice given all over this forum to use very light strokes when stropping...indeed with all of the stones, I wonder how many are lifting their bases when stropping... and if not, if anyone would be seeing similar results to what Clay has seen... whether these results are the result of true burnishing or not..

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Phil

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Re: A theory of how the WE diamond pastes work
Posted by mark76 - 31 Oct 2012 09:38

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PhilipPasteur wrote:

I guess I was trying to hint at the same question. Considering the repeated advice given all over this forum to use very light strokes when stropping...indeed with all of the stones, I wonder how many are lifting their bases when stropping... and if not, if anyone would be seeing similar results to what Clay has seen... whether these results are the result of true burnishing or not..

Just a brief quote from Clay:

wickededge wrote:

I removed the sample and cleaned it well, the completed 5 strokes per side with **firm** pressure using .75um CBN on cow leather.

I don't know whether you've read the posts on my blog regarding stropping, but in some experiments I did over 500 stropping movements per side. That is a lot, and in order to see effect more quickly I used quite a bit of pressure.

My pictures are not nearly as good as Clay's, but my conclusion was definitely that burnishing occurs, and that the WE pastes excel at doing this. That's why I started this threat. You can read all of my posts on stropping here.

That is not to say that the common knowledge that you have to strop lightly is a myth. I don't know exactly where the idea of stropping originated, but it has been widely used in the straight razor world for over a 100 years. If you use too much pressure on a straight razor, with an edge that usually has an acute angle and is very thin, you simply destroy the edge. Also, if you strop just to remove a burr (which is not necessary when you're using a WEPS), you don't need much pressure. And if you're stropping free-hand, a mistake is made easily if you use pressure, so you'd better be safe than sorry.

Even with a WEPS, if you use a lot of pressure with a leather strop and don't adjust the angle, you will round the edge. So setting back the angle (with leather I do 1 or 2 degrees) is necessary if you use a little force.

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Re: A theory of how the WE diamond pastes work

Posted by wickededge - 31 Oct 2012 10:04

In my normal sharpening, I don't use much pressure when stropping. When I'm going for serious polish though, I use pressure at a lower angle at first and then lighten up as I get ready to finish.

The thing about lifting the base - I'm not necessarily trying to lift the base, but once my strops are well seasoned, they have enough grip that I have to try *not* to lift the base and have to lessen the pressure.

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Re: A theory of how the WE diamond pastes work

Posted by PhilipPasteur - 31 Oct 2012 10:27

[quote="mark76" post=6622]

wickededge wrote:

I removed the sample and cleaned it well, the completed 5 strokes per side with **firm** pressure using .75um CBN on cow leather.

I would never have intrepreted **"Firm"** to mean so much pressure that he was lifting the base on each stroke.

mark76 wrote:

I don't know whether you've read the posts on my blog regarding stropping, but in some experiments I did over 500 stropping movements per side. That is a lot, and in order to see effect more quickly I used quite a bit of pressure.

I did and I commented on them previously.

mark76 wrote:

My pictures are not nearly as good as Clay's, but my conclusion was definitely that burnishing occurs, and that the WE pastes excel at doing this. That's why I started this threat. You can read all of my posts on stropping here.

I think that sometimes we can start out doing an experiment with a preconception. The results will always tend to confirm that idea if we are not very careful. It is easy to just intrpret the results in a manner that confirms the theories we have going in.

I don't think you can see evidence of the kind of burnishing that Clay is talking about with 400X. This is why he wants to get time on an SEM to verify his theory.

mark76 wrote:

That is not to say that the common knowledge that you have to strop lightly is a myth. ...

Even with a WEPS, if you use a lot of pressure with a leather strop and don't adjust the angle, you will round the edge. So setting back the angle (with leather I do 1 or 2 degrees) is necessary if you use a little force.

I will look for the thread. I distintly remember Clay suggesting that just a few light strokes with leather would make a significant improvement at the edge. I think this may have been mentioned a few times actually. The suggestion was clearly that we did not need to do 500 strokes while lifting the base to get an improvement.

The point was not whether stropping with a light touch is a good idea, which I think in general that it is. The point was, if the majority of people do it this way, with any practical number of strokes, they would likely not see the effects that we are discussing.

Phil

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Re: A theory of how the WE diamond pastes work

Posted by wickededge - 31 Oct 2012 10:42

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I circled some spots on the images so we'd have some things to compare. Here is the blade after the 50# diamond plates:

and here it is after 5 strokes with the .75um strops:

In the green circle and to some extent in the fuchsia ellipses, you can clearly see signs of abrasion from the .75um CBN. In the red and aqua circles, it looks like the metal has been dragged around a little bit. It

has an almost liquid appearance *as though* it had flowed.

I don't have the background to speak to this, but I wonder, as Phil has voiced, if there is enough local pressure to move these delicate structures and deform them. I measured the little elongated structure in the red circle (after being stropped) to be 1.6um, which is very tiny. How many pounds per square inch would be needed to get something that small to flow? Even more to the point, can the leather grab surface molecules and shift them, like buttering bread? The next round of testing should be interesting. I'll try it with alcohol moistened strops with no abrasive other than the grain of the leather. Once the plain paste comes in, I'll try to duplicate the level of stiction I'm getting and test that way too, maybe on kangaroo.

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