Further Testing of New Graphite Spray for Decarb/Scale Protection—Revised

I still have several tests to run with the graphite spray for decarb/scale protection—somewhat jokingly refer to as, Bellashield" or "BellaCarb". I developed it, so I get to name it!

Most of the following tests performed will determine how to clean-up the Darts. My first test will be going straight to garnet blasting for removal of protective layer.

The second test will be spraying the graphite onto a scrap piece of O1 tool steel, heat to red hot with a torch, then quench and see if it still provided protection in the presence of an open flame. I am highly dubious of the outcome, but I have to try.

The third test will be sanding the graphite surface and spraying on another coat. I will then bake the Dart at 400° F, to see if the temperature is high enough to bake it onto the blade. I will test this by wiping it with lacquer thinner after baking. If it comes off, I'll accept that a higher temperature is required.

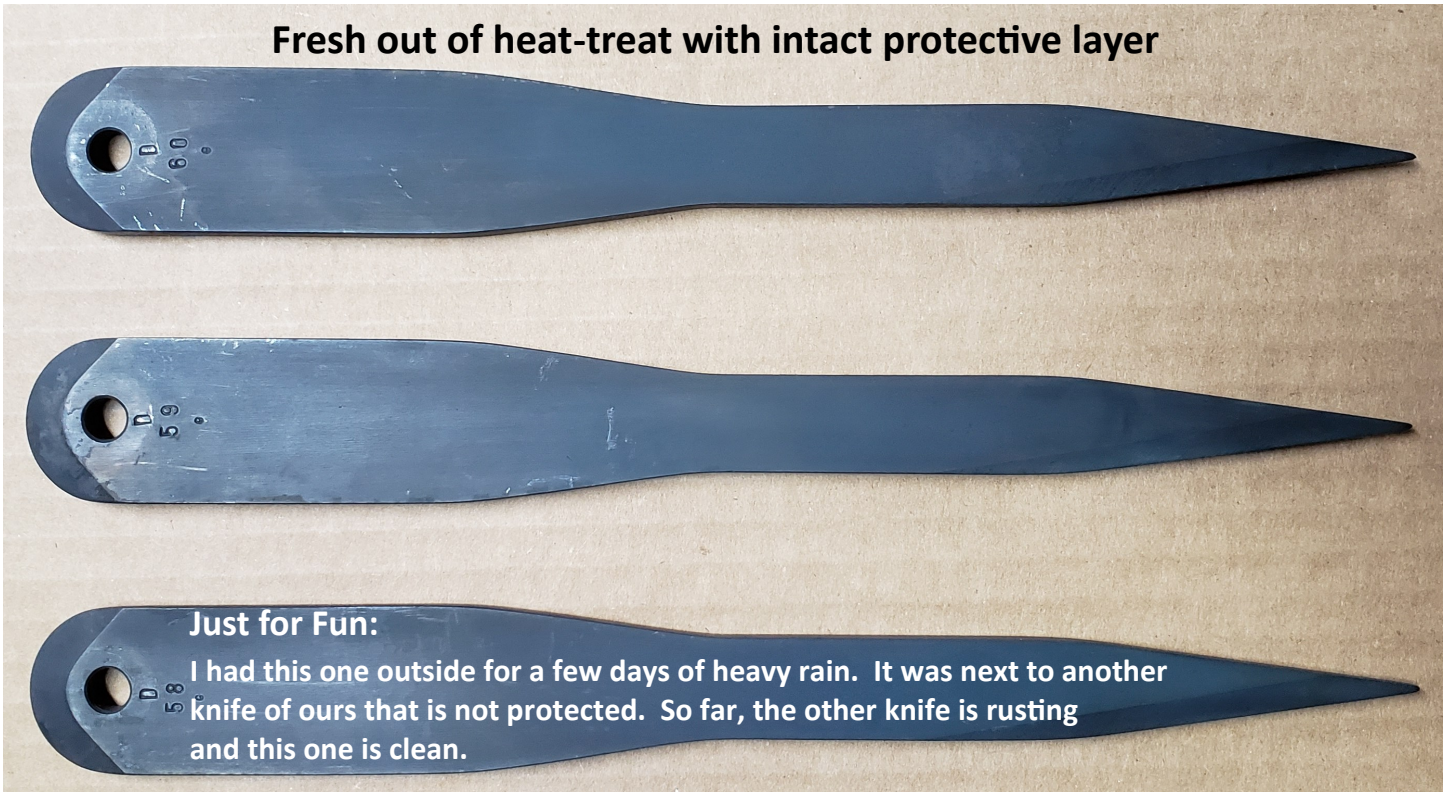
I have already determined that wiping the originally heat-treated Darts with lacquer thinner had no effect. I also know that, if it works, it will literally be slick. Who knows, some throwers may find that to be an advantage to leave the coat on the knife.

The final test will be to try soda-blasting. I want to see if this approach can remove the graphite layer while maintaining the surface texture of the Dart from before the graphite coating.

Additional test:

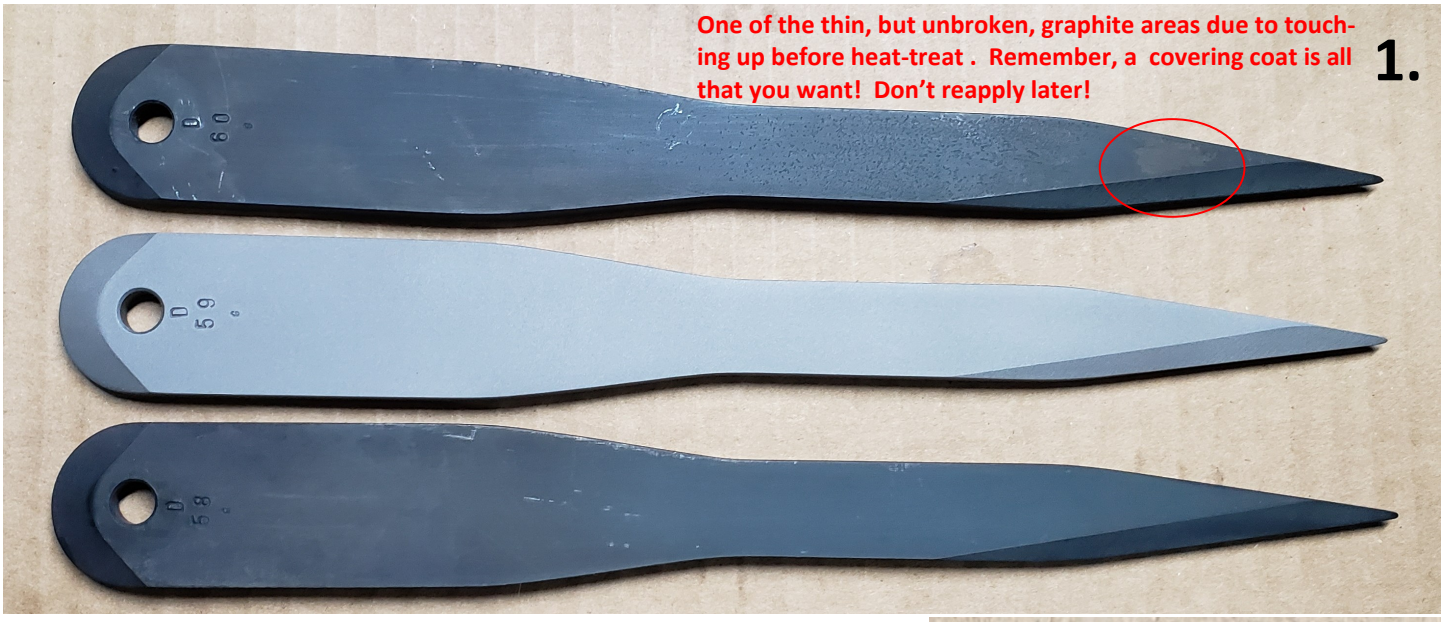
I have added one more test to this revision plus an overview of my prep for applying the graphite. I decided to test some application process variables. Specifically, I tested whether the thickness of the spray or the reapplication of it, once it has dried, is the cause of the flaking of graphite. It turns out that reapplying after providing the initial coats, heavy or light, is the culprit. I also tested hardness after the quench to determine if there was any decarb.

Below are the three Darts after the original heat-treat, showing intact graphite layer.



First Test: Graphite Spray Cleanup

In the past, we had to hit the Darts with the 120 grit (upon occasion, 60 grit) belt to remove any minor blemishes before garnet-blasting—the final finish. After admiring my work for as couple of days, I decided to see if they cleaned up with just garnet blasting, skipping the belt-sander. The results are below.



One of the thin, but unbroken, graphite areas due to touching up before heat-treat . Remember, a covering coat is all that you want! Don't reapply later!

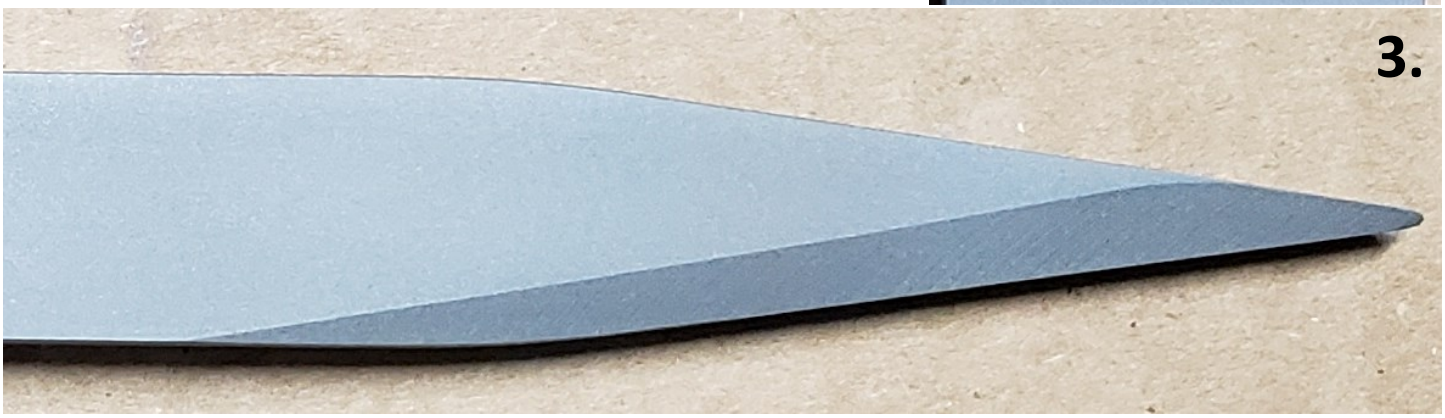
1.

1. D59G <u>after</u> 80 grit garnet blasting, compared to <u>before</u> (D58G and D60G after heat-treating).
2. Close-up of handle bevel and serial number.
3. Close-up of tip showing sharp bevel line, due to lack of need to use the belt-sander for clean-up.

2.

The Bottom Line

Once blasted, I found no hint of minor scale or decarb. There is little difference in the final result, relative to my old decarb powder and clay, but the effort that goes into it is significantly reduced. The surface was as clean as when I sprayed the graphite onto the for heat-treating. The clean-up time has been reduced and the result may, *may* be cleaner looking. The last is a subjective statement based on my excitement regarding how well this actually worked.



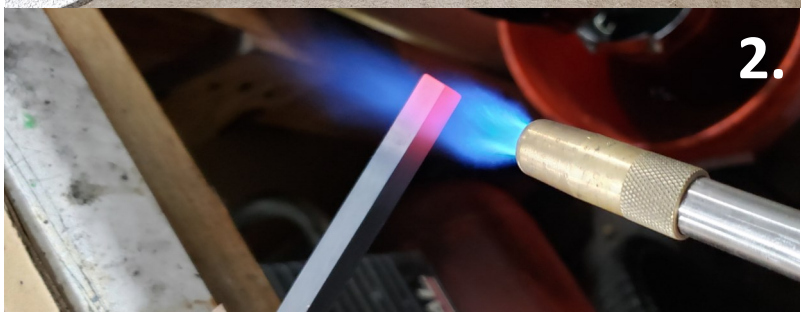
3.

Second Test: Preventing Decarb and Scale in a Propane Forge

Although we don't use propane for hardening any more, I wanted to see if the graphite layer could be maintained in the presence of a direct flame. My test shows that it can, under the conditions presented. That does not necessarily mean the process can provide decarb/scale protection to the intense flame of a forge, but it does suggest that further testing should be performed. Since we have no desire to test this capability further, it falls to anyone who would like to benefit from the possible use of graphite as a protection against decarb and scale in a propane forge. This test proves that it might work! Any takers?

Steps for this test:

1. Spray a thin coat of graphite onto one end of a scrap piece of O1 tool steel.
2. Heat to non-magnetic with a propane torch. Periodically remove from heat, exposing to more oxygen, then re-heat.
3. Quench—post-quench shown. Graphite appears to be intact.
4. Clean with 220 grit and test hardness with a file—very hard! No signs of scale or decarb.



Third Test: Applying a New Coat of Graphite and Baking

I performed this test just for fun. I wanted to see if there would be any bonding to the surface of the steel at a temperature of 400° F. So, I first wiped down the Dart with lacquer thinner. No effect! Before placing it in the furnace and running the temp up to 1460° F, it could be wiped off easily. **The original graphite is apparently baked on!**

I then wet-sanded the Dart with 400 grit by hand. I was able to remove some, but not all, of the extremely thin layer of graphite. I then applied a light spray of graphite (always a light spray) to the Dart and allowed 15 minutes to dry. I then placed it in the furnace for one hour at 400° F.

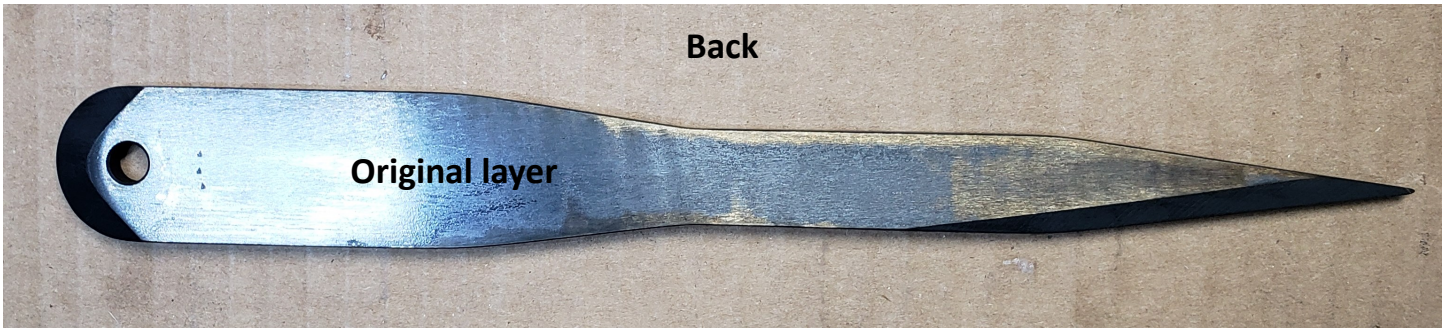
Upon removing the Dart and rapidly cooling, I once again used lacquer thinner to determine the level of bonding to the surface. Remember, after heat-treating, the graphite layer had previously been impervious to lacquer thinner. The rag wasn't even discolored. The result from the low temp baking is shown below.

While what was left of the original layer remained untouched, most of the new layer came right off, exposing a straw colored metal surface from the 400° F furnace. This was not really surprising, but since early results were so surprising, I figured it was worth the effort.

Since there was still a sufficient layer of the original graphite on most of the Dart, especially the handle, I decided to use it to test soda-blasting to remove the graphite in order to maintain the original surface texture.

You can see below, the straw color where most of the extra layer of graphite was removed with lacquer thinner. Notice the original layer, mostly on the handle, was still in place.

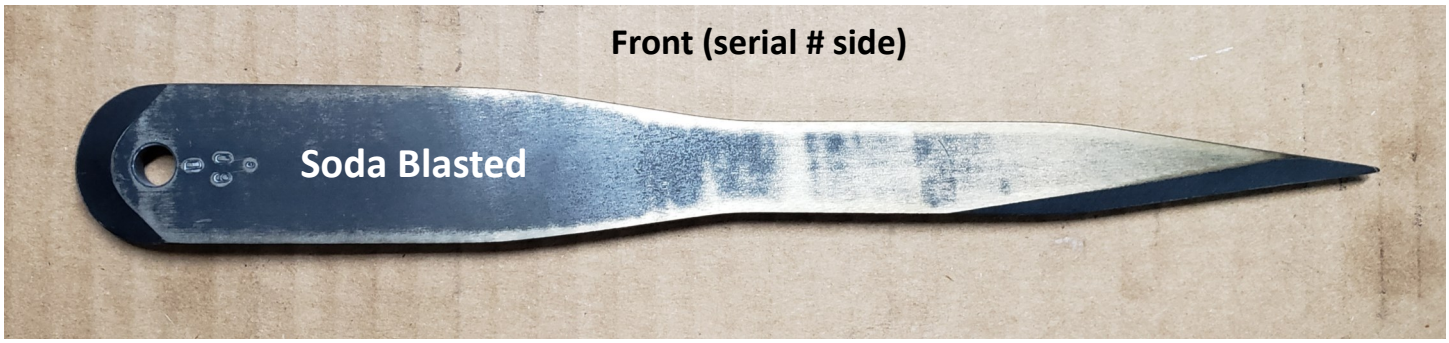
Next stop: Soda blasting!

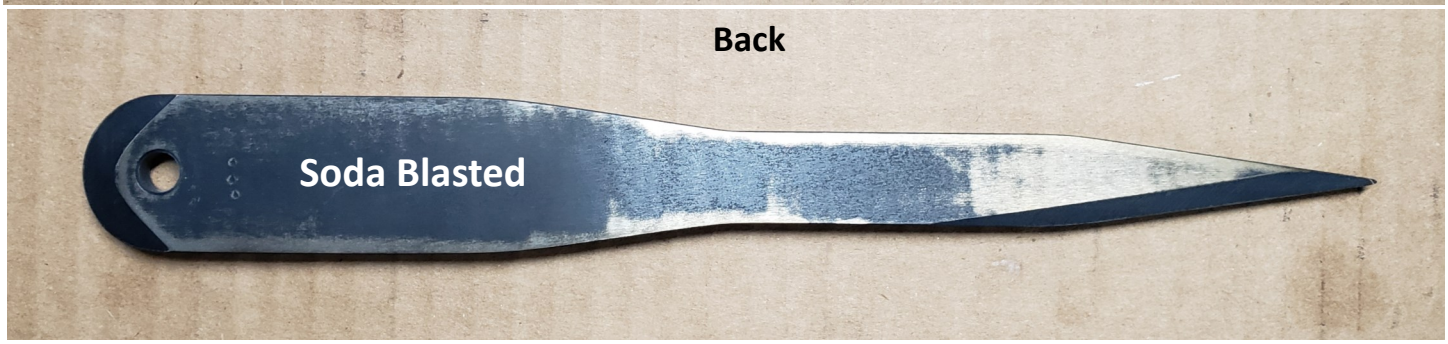


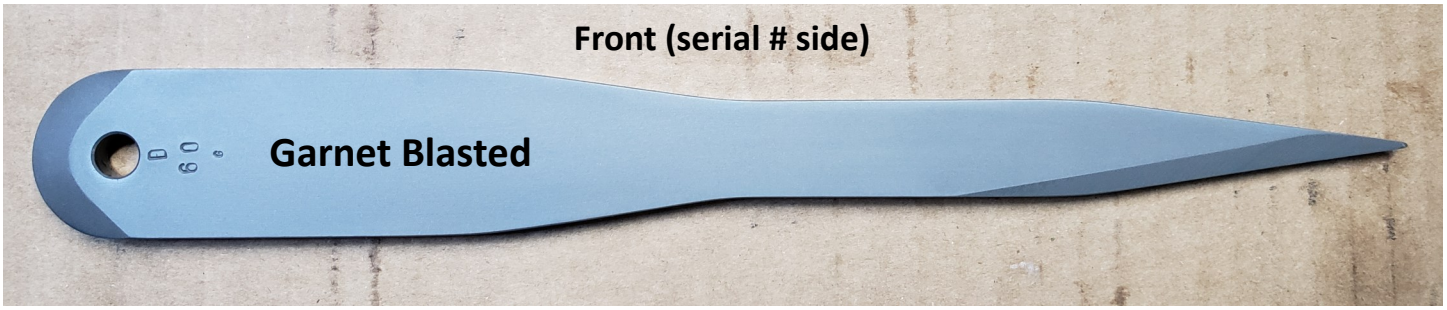
Fourth Test: Soda Blasting to Remove Graphite Coating

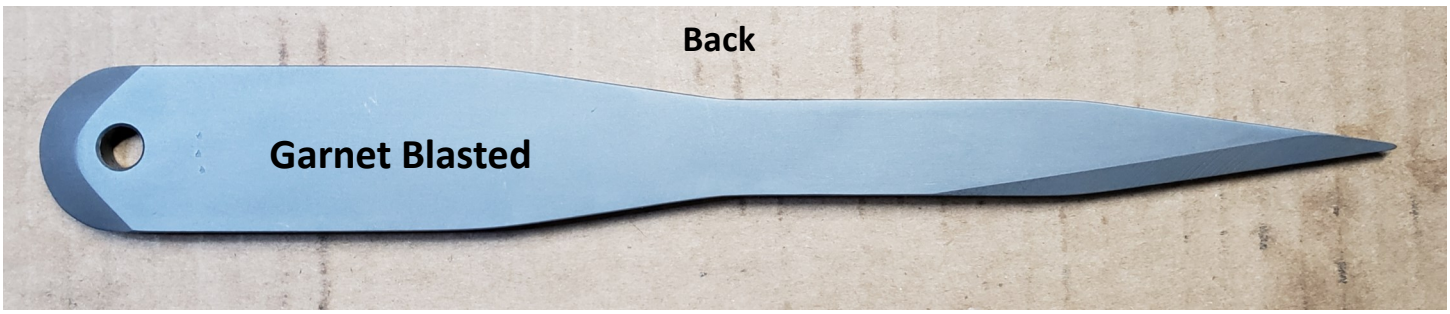
This is the result of blasting with course baking soda at 125 psi. Not a lot! All it did was dull the remaining original graphite coating, leaving the straw colored steel untouched. When I saw the results, I decided to give up and garnet blast it, like I do to all of my Darts.

We garnet blast because it provides a strong bonding surface for powder coating and provides a darker finish with black oxide.









So, that's where we are at this time. I would appreciate further feedback from anyone as to how well this worked for them. I would especially like to get more feedback regarding use in a propane forge. So far, it does seem to work!

OK, Let's Go Through the Process

Yes, I am sacrificing two more test pieces in the name of experimentation. After some comments from others, I decided to see if thickness of application or timing of application would cause any issues. So, I cut some 6" pieces of O1 tool steel and stamped them "L" for light coat of graphite and "H" for a heavy coat. I was going to stamp them with letters for thick and thin, but decided to avoid confusion.

As I had previously mentioned, I grew up painting cars, so I know that PREP is critical! The surface must be clean! My cleaner of choice, in this case, is lacquer thinner. It works great on cuts as well!

Shown below are the two test pieces, straight from the metal supplier after I cut and drilled them—no sanding and no polishing. Next, I wiped them down with the lacquer thinner (shown below) and placed them on wire hangers for spraying. I wear Nitrile gloves for this part of the process, just like I do for powder coating.

The "L" piece was given two light coats of graphite plus an extra coat on the top (hole side) several minutes later. The "H" piece was heavily sprayed with multiple coats over a short period of time and also coated on the top several minutes later.

After coating, waiting and coating the top of each again, I waited ~10 minutes then picked them up and placed them in the furnace. I then started the furnace and slowly heated it to 1460° F, as always. Once it was up to temperature, I allowed them to soak for 15 minutes before quenching.

The results were consistent—both had a graphite layer that peeled off the top when wiped down after the quench. I should have saved some for pix, but in my haste, I just shook it out of the rag. The rest of the graphite, including the layer under the portion that flaked off, was undisturbed. Also, I could not see any difference between the pieces before and after the quench.

Pictures:

1. Lacquer thinner used for cleaning—any lacquer thinner will do.
2. Drilled and stamped test pieces before cleaning.
3. Same pieces after heat-treat.

After the First Temper @ 330° F

After removing the test pieces from the oven, but before placing in the furnace @ 750° F for their final temper, I decided to test them for hardness. This is not something that I usually do, but I wanted to see what their pre-temper hardness would be. According to several sources, the HRC of O1 tool steel for a 330° F temper should be from 60 to 63. Also, my rebound tester always indicates a lower hardness when the area under test isn't polished or at least very smooth.

Earlier, while preparing the pieces for the graphite spray, I observed that the texture of each of the pieces on one side is a bit courser than the other side (visible striations on "H" piece shown below). Unfortunately, I noticed them after I stamped and before I prepared them for the graphite coating. It may, or may not, have affected the hardness test. So, given the hardness numbers shown, I'd say there isn't any sign of decarb. I should mention that I tested <u>through the graphite</u>!

Before testing them for hardness after the low temp oven, I wiped them both with lacquer thinner. No effect! I must assume at this point that the graphite layer is indeed baked on.

So, it seems that a properly cleaned and prepped piece that is given a good covering coat, without reapplying before heat-treating, should be totally protected from decarb and scale without shedding any graphite. Having performed this procedure three times, once with a single test piece, again with a set of three Darts and now with these two pieces, I am comfortable stating that it is the easiest and most effective approach to protecting O1 tool steel during heat treating. I'm sure it can protect other metals at other temps.

I must also mention that I used a micrometer to measure the steel pieces before applying the graphite and they both measured 0.2509". After the final temper, I measured again: 0.2509". I was expecting some additional width, but I could not discern a difference down to 1/10,000". Yes, I checked calibration both times!

Upon further research, I found two different graphite sprays that stated a coating thickness between 2 and 30 microns (0.000078" - 0.00118". Of course, that is without going through a heat-treatment!

Another consideration is the concern over getting a higher temperature graphite spray. Since the normal purpose for graphite is as a dry lubricant, I must assume that the maximum temperature stated is not relevant to our purposes as knife makers. I am hoping to hear from others regarding their results in this area. For now, I know that it works at least up to 1460° F, even though as a lubricant it is rated at 850° F.