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Subject: Silver soldering

Posted by [aeron203](#) on Thu, 04 Aug 2011 15:07:52 GMT

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I am in need of advice about how to approach a repair for a silver piece. I ordered a design in silver, unpolished. I wanted to do the polishing myself, since there are hidden areas that would need to be hand polished anyway. I got a message from Shapeways QA detailing some problems with bubbles in the details. This is an important project that is already far behind schedule, so there is no way I could order it again. I accepted the part hoping it could be fixed by a jeweler or myself.

Removing the nodules was not easy, and it took several hours of gentle Dremeling and hand sanding to flatten the surfaces without taking down the details. I noticed a soldering repair where one of the petals touches the center sphere. Unfortunately it had been soldered off-center, and when the piece cooled there was a lot of tension that was actually strong enough to bend the whole thing like a banana. Just holding the piece in my hand to sand it was enough to break that connection. At first I was not that bothered since I saw it as an opportunity to straighten the thing out. Below you see the petals and sphere sanded and ready to be bonded with correct alignment.

I took it to a jeweler, and to my surprise she said they can't fix it! They may not want to take the risk of melting the piece, but obviously the people who made it are able to make repairs. I made an attempt myself using a propane torch, but I was not happy with how it was going and I really don't want to damage it further. I have experience brazing copper and aluminum, but this was not reacting the way I expect. The flux burned away and the metal tarnished before the solder got to melting temp.

Are there any silver-smithing Shapers out there who have any advise on how to do this? I'd like to use a lower-temp "soft" solder. Can I use silver electrical solder? I know it's not as strong, but I don't have any specialized materials or equipment and the piece will not be worn so it doesn't have to be bulletproof.

Can anyone help me?

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Subject: Re: Silver soldering

Posted by [stop4stuff](#) on Fri, 05 Aug 2011 17:22:26 GMT

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I don't know where you are in the world, but it might be worth your while putting a shout out on the Brass Goggles Steampunk forum - theres several people there that regularly use and advise about different silver solder methods.

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Subject: Re: Silver soldering  
Posted by [aeron203](#) on Fri, 05 Aug 2011 18:04:57 GMT  
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Thanks. There are a few jewelers on here so I thought I'd give it a shot in case someone has already tried this. I will definitely ask around at some more specialized forums. I'm also shopping around at more local jewelers. I'm still in disbelief that a professional jeweler cannot do this job.

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Subject: Re: Silver soldering  
Posted by [GlenG](#) on Sat, 06 Aug 2011 00:23:57 GMT  
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Hi Aaron,

Is the piece in the photo printed in SS or is it a silver casting? Either way you could use soft lead free solder but you will need to clean off all traces of "burnt flux". After that, , cut a tiny snippet of solder allowing just enough to fill the joint, flux the part and lay the snippet in place. Heat slowly and gently and do not concentrate the heat directly on the joint.

-g

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Subject: Soldering success!  
Posted by [aeron203](#) on Sat, 06 Aug 2011 05:09:15 GMT  
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Thanks Glen. This is a sterling piece. I have not yet received the steel for some reason.

I went back and gave it another shot, changing my setup a little. I do think the issue was with uneven heating, which is apparently what caused the faulty repair in the first place. I decided to clamp the part further away from the work area and insulate it with a piece of fiberglass. Originally, the vise was drawing a lot of heat away from the petal it was clamped to, cooling it and causing uneven expansion of the metal on that side.

I also decided to leave the flux off until the entire piece reached working temperature. As soon as the solder began to visibly soften, I added the flux and pressed the parts together. Below you see the results immediately after bonding.

There was more material than I wanted, but at least I could be sure it covered enough area, and it was very easy to shave away excess with a razor. Below is the post-polish shot. Not perfect, but it looks nice and strong (solder joint on left in this image).

The little Dremel buffing wheels are still too big for many of the details in this design, so I found another solution. I have been cutting Q-tips in half and using them as polishing bits. They last maybe 30 seconds but they're very effective. I learned you have to be careful polishing hard-to-reach areas because a tiny bit, even a Q-tip, can leave a noticeable divot if too much polishing is done in one area. The best technique is to make a very gentle transition between the totally polished surface and the unreachable surface. The nodules from the casting bubbles are long gone. Below you see that surface before polishing.

After cleaning with sulfuric acid and more detailing with Q-tips, the piece looks really nice. The solder is a little darker and duller than silver, but you would never notice it unless you were looking for it.

My conclusion is that silver soldering can be done well with very basic tools if you approach it the right way. Ideally we would just make designs that don't need to be repaired though! The design is a parametric CAD model, so I can easily adjust the radius where the petal "kisses" the sphere and guarantee my customers will get a solid product. It is definitely better to play it safe if the aesthetics of the model can handle a sturdier design.

This model is the centerpiece of a larger composition so I am greatly relieved to have done this without destroying it and setting myself back a month.

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Subject: Re: Soldering success!

Hi Aaron,

Whatever works is the final word I suppose. So forgive me if I add a few more comments on this procedure. The more experience you have with soldering a variety of metals you will notice differences in thermal conductivity. This is a big factor when soldering silver and copper alloys. Higher thermal conductivity effects how much heat input is required to get solder to flow and this can also affect warpage and distortion. You will also notice that heat induced distortion will vary not only with specific materials but also how the actual parts were manufactured ie. casting, machining, 3dp etc. All of these factors can be compensated for to produce good results. It is largely a matter of experience when determining the best procedure for any given job.

Silver has an extremely high degree of thermal conductivity so it is essential to preheat the entire part before concentrating on the area to be soldered. It is safer practice to flux the joints prior to ANY heating as oxides will begin to form even at relatively low heat. The pre heating should be done by holding the torch flame several inches away from the parts, like 2x or 3x further away than when you are actually soldering the joint. Be patient, take your time. "Slower is better" should be your mantra. No harm is done until you overheat/burn the flux. No amount of praying or cursing will help once the flux turns black. You must quit and scrupulously clean the joint area and try again. Invest in failure and learn from it! Anyway, after a gentle overall preheat, you can now bring the torch in closer to the joint area, but resist the temptation to point the flame directly on the joint. Keep the flame dancing around the joint area. Do NOT concentrate the flame in one area, EVER! Watch for the flux to change, it will appear clear and much cleaner than the unfluxed regions. The solder should now flow instantly into the joint. When it does, back the torch way off for a few seconds, playing the flame around the whole part in a circular motion and you're done, allow to aircool. These principles are the same whether you use low temp lead/silver/ tin solders or high temp industrial silver solders. The big difference being, you are much closer to the edge of disaster when using hi temp solders!

As to minimizing distortion: Often times some form of fixturing is required. Jewelers/metalsmiths traditionally use what is referred to as "binding wire", this is fine gauge uncoated steel wire usually between 20g-30g. On large parts heavier gauge "baling wire" can be used. On your piece I would have fashioned a temporary ring clamp by twisting together the ends of a short length of binding wire and slipped this loop down to the widest area of the part to hold all the "petals" in alignment. Using a pair of jewelers needle nose pliers you can adjust the tension of the wire to gently bring parts into contact which will produce cleaner and stronger solder joints. Avoid over tensioning as this can cause more problems that it solves.

So, if it was me soldering this piece, I would have set the part vertically on a fire resistant brick, not used a vice, maybe a tweezer clamp at the base for stability. Used some binding wire, fluxed the top 1/2" of the part, layed a snippet of solder on the joint, started a slow preheat at the base of the part (count 20-30 seconds), by now heat should be even throughout the part, then a quick

burst of heat near the top, voila job done. But, as always, the important thing is....whatever works!

-G

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Subject: Re: Soldering success!

Posted by [GlenG](#) on Sat, 06 Aug 2011 18:00:12 GMT

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Aaron,

one more thing. Sulpuric is not the best choice for cleaning (pickling) silver, especially a casting (because they are somewhat porous). If you use sulphuric, afterwards you should boil the piece in an aqueous solution of sodium bi carbonate (baking soda). This will neutralize the acid. A safer option is to use a solution of sodium bi sulphate, this is sold commercially as "Sparex" and is pretty much the industry standard for pickle solutions.

-G

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Subject: Re: Silver soldering

Posted by [aeron203](#) on Sat, 06 Aug 2011 20:10:23 GMT

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Your detailed description is much more helpful to people reading this than seeing my before and after pics, so thanks again for contributing to the knowledge base here. The workflow you describe is basically what I went with minus the additional wire fixture and earlier flux placement.

I'm glad I know a little more about repairing silver, but I am not keen on buying equipment and materials that will only be used when there is a problem with my design. Copper, aluminum and steel are the focus of my usual work in metal, because I often design larger, functional things. I'm happy to work with specialists who have spent a lifetime honing their craft, so I would rather try to recognize that and avoid of losing focus on what I actually do. It is always good to get more experience with more materials, though.

I'm happy it turned out OK, but I would be much happier if I had not had to spend so many hours dealing with these problems, when I thought I was in for a simple polishing.

I'll probably just address these issues through the design specs in the future, and I will not sell my silver products unpolished.

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Subject: Re: Silver soldering

Posted by [BillBedford](#) on Sat, 06 Aug 2011 22:08:44 GMT

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The surface of the ball in your piece was smooth, which suggests that the problem was that it was not properly attached in your original file. Had the ball parted from the support after the piece had been built I would have expected an uneven or fractured surface.

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Subject: Re: Silver soldering

Posted by [aeron203](#) on Sun, 07 Aug 2011 16:32:24 GMT

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The photo above, as I described it, is showing the piece after the old solder has been sanded away. I'm sure you know the importance of blending surfaces in a model because you made a post yesterday with images illustrating the effect. Filleting inside corners might be new to those most familiar with creating polygon-based models, but for an industrial designer with more than 10 years of solid-modeling experience, this is bread-and-butter. The attachment in the original model was exactly what I intended because of how it was constructed. In the screenshot below, you see the blend that I originally defined. The blending operation is applied to the sphere, not the petals, so all intersecting surfaces are blended at once, reducing the chance that I might miss one.

Even though the "neck" is more than 1mm wide, this is still an area where a lot of force gets concentrated, so of course I'll have to nudge it out in the new versions. The updated model below uses a 0.25mm chamfer, which makes a straight line about 0.5mm long. Aside from keeping poly counts lower, a chamfer leaves more material at the joint to prevent a weak spot. After polishing the angles will soften.

I noticed inaccuracy at more than one joint, so there is a possibility the disconnections were made on purpose to control the flow of the casting. We have seen evidence in Trompevenlo's postings of significant modifications made to the cast parts that are then soldered together. In that case it doesn't matter what I do with my model. They may be disconnecting three of the four petals and re-attaching them later. That would then need a complex fixture like Glen described, and increase the likelihood of inaccuracy. I strongly prefer that my models should not be taken apart, so if large loops or other features are a problem for people doing the casting I hope we receive feedback about their process so we can produce more accurate models.

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Subject: Re: Silver soldering  
Posted by [GlenG](#) on Mon, 08 Aug 2011 17:53:20 GMT  
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Aaron,

You said it yourself, "The blending operation is applied to the sphere, not the petals". Could it be that the fillets you created are merely touching the surface rather than truly intersecting? This could definitely cause a nearly invisible gap between the sections, even a few microns could lead to failure. Maybe consider simply increasing the ball diameter a tiny amount thus allowing it to truly intersect the "petals". I'm not convinced you would need any filleting if you did this. I suppose it couldn't hurt though. The prime objective here is to insure these design elements are in fact one piece and not just touching

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Subject: Re: Silver soldering  
Posted by [aeron203](#) on Mon, 08 Aug 2011 18:03:34 GMT  
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It is a Solid Body. Are you sure your torch is on?

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Subject: Re: Silver soldering  
Posted by [BillBedford](#) on Mon, 08 Aug 2011 19:19:22 GMT  
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It would still be a solid body if the sphere was only attached to one petal.

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Subject: Re: Silver soldering  
Posted by [aeron203](#) on Mon, 08 Aug 2011 20:08:46 GMT  
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Now you're just trolling, Bill.

Are you really looking at that close-up screenshot from a CAD program showing a filleted solid model and picturing a tiny imaginary gap for no reason?

I am happy to hear constructive criticism, but I am the guy who built the model. I am telling you

straight out that I am absolutely positive I have built the model correctly and that the petal and sphere are intersecting, otherwise the fillet would not even work. I would like you to show a little more respect for my area of expertise. I came here humbly requesting information about soldering silver, which is a new metal for me. Specifically if asked I could give it a DIY shot with regular equipment without damaging it. Instead of simply watching a Youtube video I decided to share my experience with the community in case someone else needs to try this. After Glen gave the go-ahead for regular propane/solder I did it with no trouble at all, before Glen launched into his lecturing explanation and you tried to teach me about solid modeling.

I improve my models after every print, but in this case my model was exactly as I intended it to be, and I'm disappointed that I have to harm my design by straying from my original intent, just to accommodate a flaky production process.

Thanks for answering my question Glen, but next time I'll just send a PM and stay away from the forum.

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Subject: Re: Silver soldering  
Posted by [stefan\\_z](#) on Fri, 12 Aug 2011 00:55:06 GMT  
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Nice design - must have cost a fortune in silver!

I would have designed the arms without the ball and added that later by hand.  
I guess that would give less tension and much better possibilities for re-bending the arms in case of a twist or distortion.

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Subject: Re: Silver soldering  
Posted by [aeron203](#) on Fri, 12 Aug 2011 15:16:10 GMT  
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Thanks. It was designed as a gift so cost was not the primary consideration.

I'm also selling it as a customizable model for anyone who wants one - Steampunk Stamp co-creator, so that rules out the idea of doing manual post-processing work for each part. The connection actually helps the part survive it's "green" stage. The unsupported petals are four inches long, so it's very likely they would be bent or broken without some support, so the model also would have been rejected without the sphere.

The main issue here is that it is essentially a thin, eight inch long model that wraps back on itself. Combined with the rapid change in cross-sectional area, I am presenting a worst-case-scenario to the printers, even though I am conforming to the stated design rules. I do as much as I can to compensate for it in the design to make it work, but much of my design relies on a sense of visual tension that causes shapes that are impossible for most processes, and barely possible for 3D-printing.

I know there is still some disbelief and a tendency to point at the model as the problem, but responsibility needs to be shared by all parties if advancements are to be made with this technology. All I ask is that everyone does their best and recognizes the efforts and skills of the other people involved. I am honestly not messing with anyone here with these models. These types of challenges have value. I dropped a bomb on ProMetal last year with the TimeKeeper and a copy of that model went straight to the president of the company. I ended up with a distribution deal, but I'm sure they're glad there is only one of me.

In the future I'll try not to cause so many headaches for guys like Glen who have tons of knowledge and experience to contribute. Those people are very valuable especially because Shapeways does not employ anyone with much technical knowledge in fabrication (or at least they are apparently not in a position to influence these issues). It is an internet company and their model is to outsource most of that stuff and fill the gap with solid customer service policies and volunteers on the forum here. So far I think it is working great!

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Subject: Re: Soldering success!  
Posted by [erckgillis](#) on Tue, 18 Oct 2011 20:22:52 GMT  
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Yes HCL and Boric Acid as a pickle solution work best to remove firescale and oxidation. Commercial flux and pickle solutions are also available.

great thread!

Ed

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Subject: Re: Soldering success!  
Posted by [duann](#) on Wed, 19 Oct 2011 00:06:04 GMT  
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Thanks for Sharing Aaron.

Great work

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