VANISHING ACT

How Hot Isostatic Pressing can make porosity disappear

BY TERESA FRYÉ

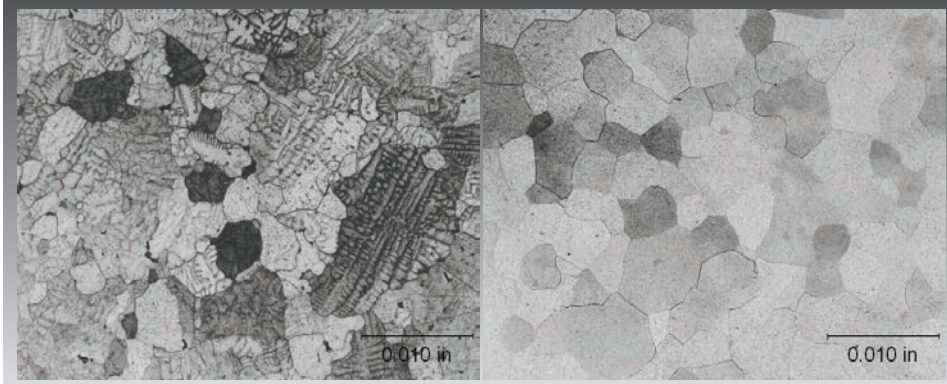
Editor's Note: *This article is excerpted from "Platinum Alloys in the 21st Century: A Comparative Study," a paper by Teresa Fryé and Joerg Fischer-Buehner that was published in the proceedings of the 2011 Santa Fe Symposium on Jewelry Manufacturing Technology.*

Even the most talented platinum caster cannot escape the painful truth that is shrinkage porosity. It is extremely difficult to cast any platinum alloy and obtain results that are porosity-free. Casters go to great lengths tweaking process parameters in an attempt to eliminate porosity from the equation, but it always manages to sneak into our castings to some degree.

When conducting experiments with various platinum alloys for a paper that I presented at the 2011 Santa Fe Symposium on Jewelry Manufacturing Technology, I explored the possibility of using a technology that is underutilized in the jewelry caster's fight against porosity. It's called Hot Isostatic Pressing, or HIP for short, and after you see the results we obtained with it, you may soon become pretty hip to it yourself.

WHAT IS HIP?

HIP is a high-pressure thermal treatment process that is regularly used on investment castings in quality-critical industries, such as medical and aerospace. The HIP process involves placing the castings into a high-pressure vessel in which inert gas applies pressure to them at elevated temperatures for a specified period of time. The result is densification—essentially, the material surrounding the shrinkage porosity in a casting reaches a plastic flow point and moves into the voids. The time, temperature, and pressure used allows for diffusion bonding to occur within the metal structure, eliminating internal porosity.

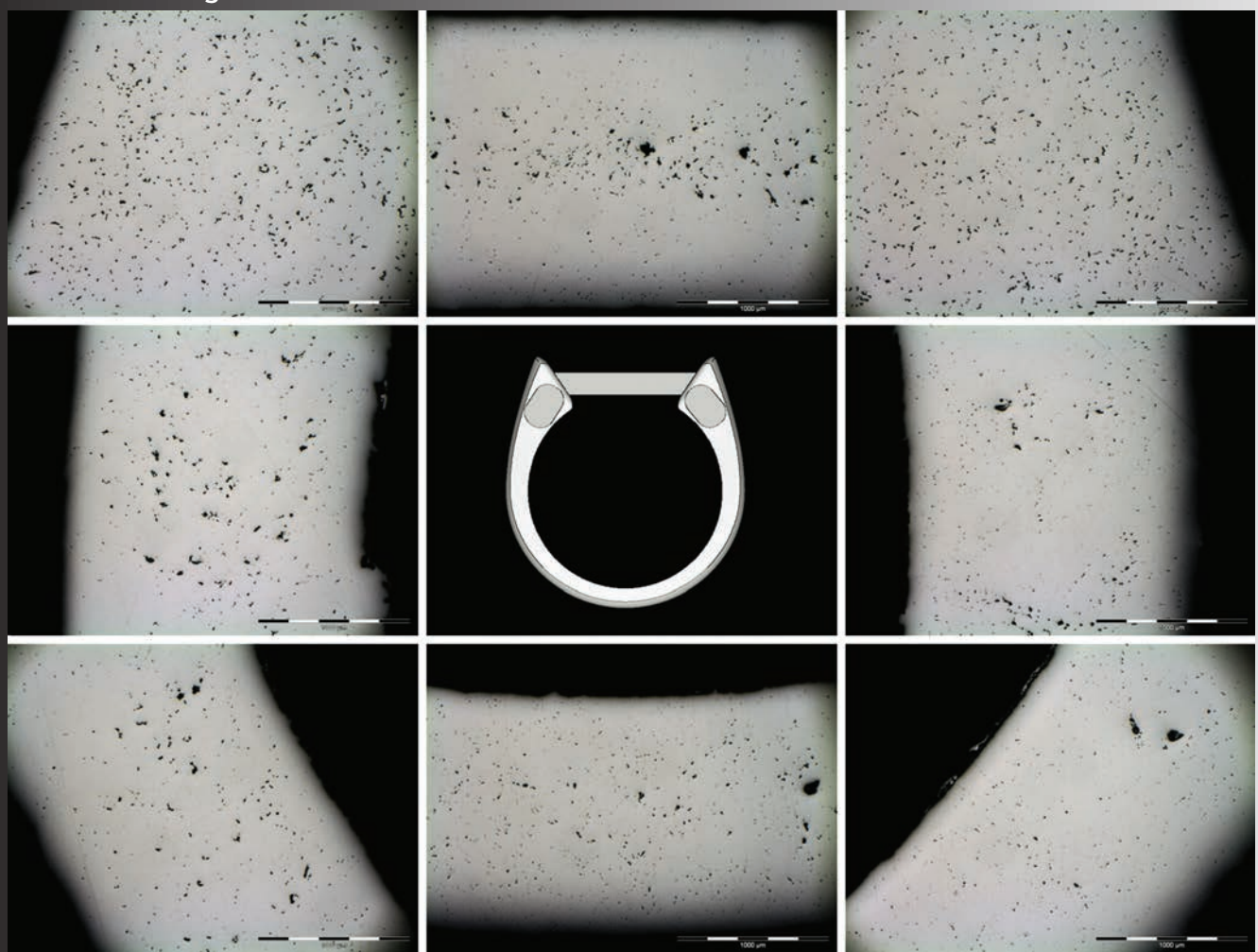


These metallographic scans show the grain size of the 95Pt5Ru casting before (left) and after (right) HIP. The similarity in grain size indicates that polishing results should be favorable on the HIPed casting.

In the experiments we conducted, we cast many platinum alloys, including the commonly used 95Pt5Ru, 95Pt5Co, and 90Pt10Ir, into a universal ring shank design. All of the resulting castings had some degree of internal shrinkage porosity. To see what effect the HIP process would have on them, we shipped castings of each alloy to Bodycote North American HIP (*bodycote.com*) in Andover, Massachusetts, a thermal processing company that specializes in HIP.

The results of this process were very impressive. Almost no porosity was left in any of the platinum castings after HIP treatment. Any microporosity detected in the initial castings was completely closed, and just a few small cavities remained in some samples that initially had large gas pores. In the metallographic sections shown below, you can see the tremen-

95Pt5Ru Casting Before HIP



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dous difference in the 95Pt5Ru casting before and after HIP.

In addition to virtually eliminating shrinkage porosity, HIP also increased the hardness of the castings by about 10 to 20 HV. While we are not yet entirely sure why the hardness increased, we believe this can be attributed to the high densification that results from this process.

The only negative result we noted during the initial trials was an increase in grain growth in the HIPed castings, which can contribute to an orange-peel effect when polishing.

HOW CAN I GET HIP?

Following these first experiments, we began working with Bodycote to develop precise HIP parameters for a number of common platinum alloys to minimize the grain growth we initially experienced in our trials. At presstime, we had achieved favorable results for the 95Pt5Ru alloy (shown on previous page). As you can see in the images, the grain size is very similar between the HIPed and as-cast product, indicating that polishing results should be favorable. To diminish the possibility of having an orange-peel effect when polishing, it was important to dial in this aspect of metallurgical quality. Continuing research will aim to confirm favorable HIP parameters for all mainstream platinum alloys. In addition, a full series of bench tests of HIPed platinum jewelry is currently underway with a number of jewelers across the country.

For anyone who has cast a beautiful platinum ring only to begin polishing it and reveal small, scattered voids that just seem to multiply the more you try to get rid of them, this technology may be a powerful solution. The fact is, it's nothing new: HIP has been in use in the aerospace and medical casting industries for years, but it may be time for the jewelry industry to adopt this process for its own benefit. When it comes to platinum, in particular, every bit of metal lost at the bench during repairs adds up quickly. Moreover, the relatively high labor rates at North American manufacturers make high quality castings an increasingly important part of a profitable business model. Stay tuned: The HIP process might just be the answer to better quality, lower metal loss, and higher profits. ◆

95Pt5Ru Casting After HIP