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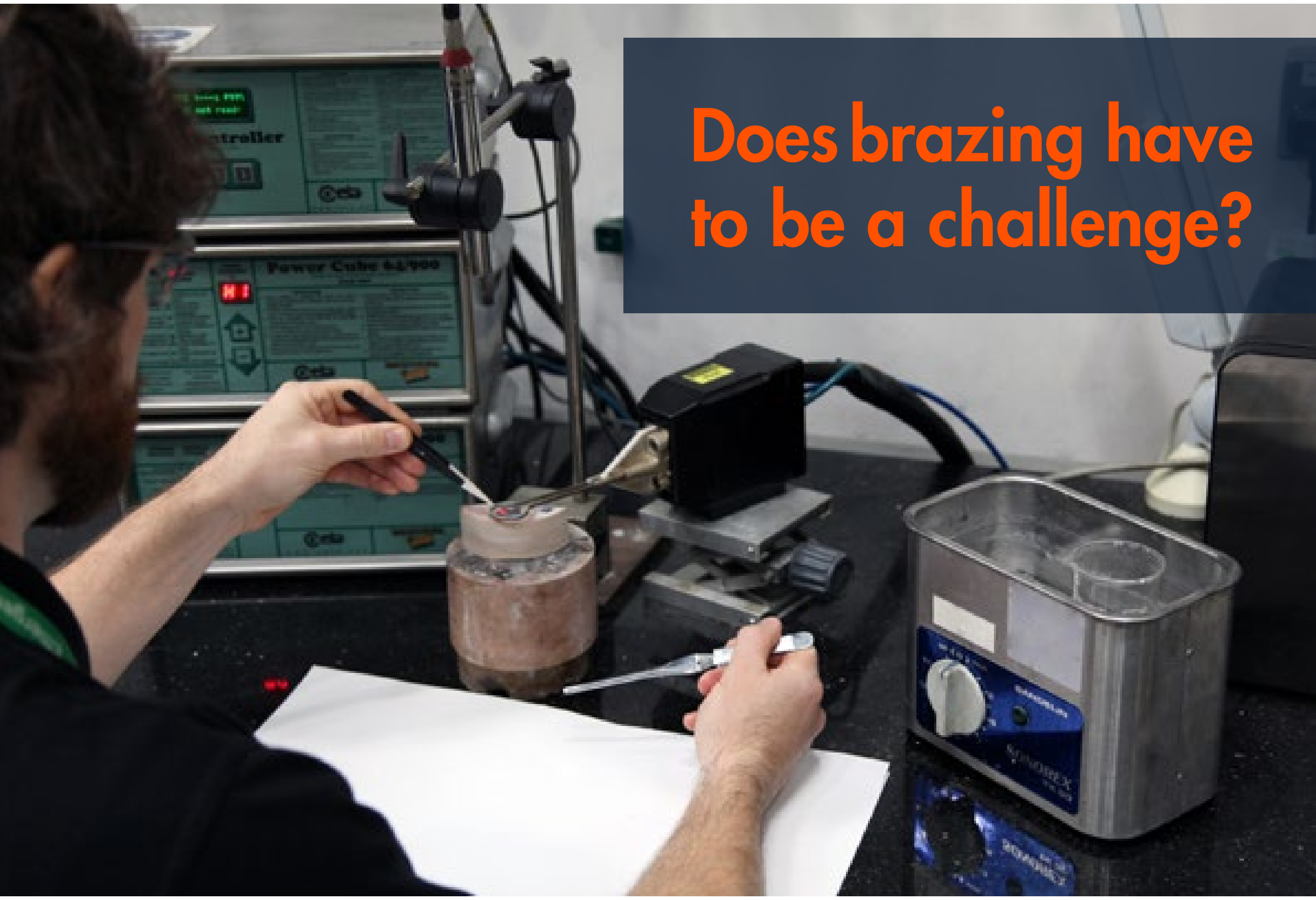


Does brazing have to be a challenge?

Brazing often represents the most problematic process within a tool-making production cycle. However, with care, attention to detail and the right knowledge, this process can be stabilised.

There are multiple techniques for achieving an effective braze joint. Whether it's through the use of a furnace, induction or resistance heating, active or non-active brazing, there is always a process for the desired outcome. Due to superhard materials' relative sensitivity to temperature, Element Six does not recommend the use of direct flame for heating as precisely controlling the temperature can be difficult.

Take time to design the joint before applying heat; appropriate pocket shape and size, segment relief, correct size of segment, choice of alloy and format, correct flux, atmosphere and heating regime are all critical.

Preparation prior to heating

When designing a braze joint, the two key aspects to consider are; keeping the temperature as low as reasonably possible, and the size, shape and location of the superhard element of the segment. Peak temperature will depend on the braze alloy, with suitable strength, selected for the application.

Ensuring the superhard element of the segment has the correct relief, either through engineering the segment itself or the pocket, is important to eliminate cracking and premature failure. Figure 1 provides examples of possible relief options.

Information for braze alloys and the resulting joint strength can be sought from alloy suppliers. Alloy formats vary in conjunction with the tool and joint design, with foil and paste being the most common and easy to handle. (Note: some pastes require refrigeration to prolong shelf life, so check with the supplier).

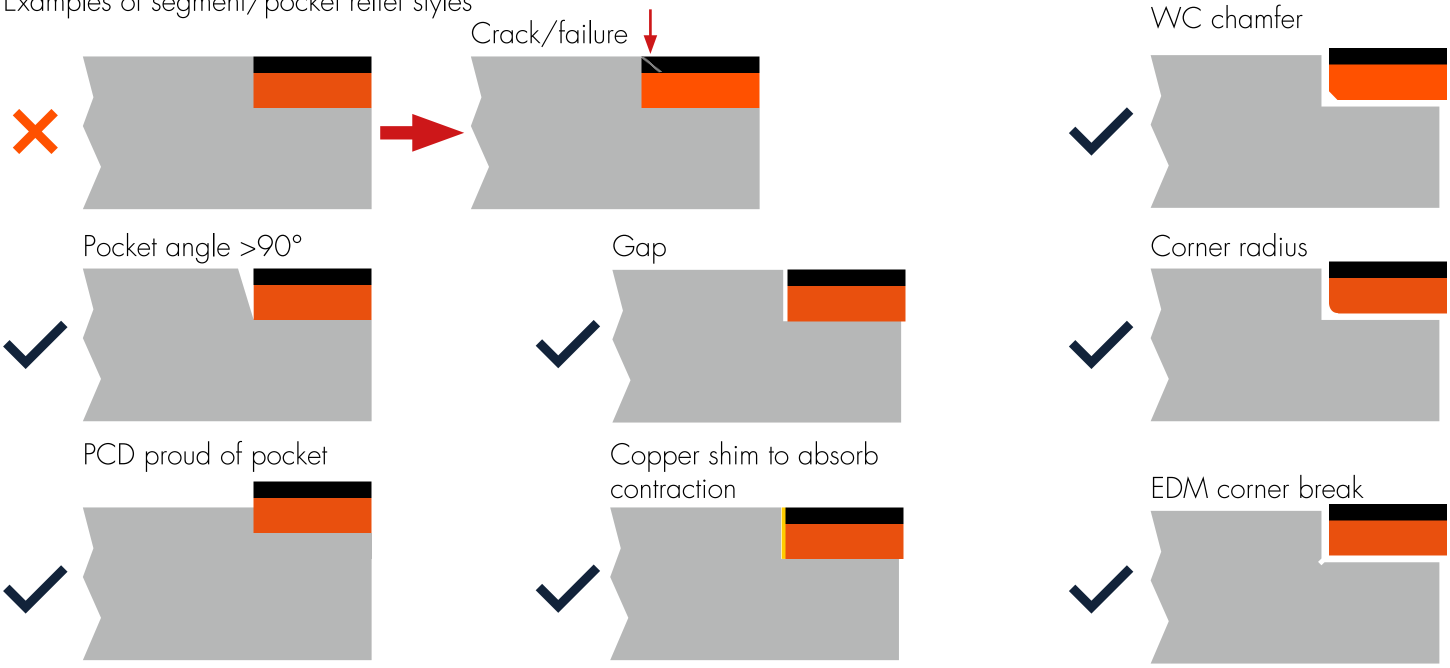
Once all the constituent parts of the joint have been prepared (superhard segment, tool body and braze alloy), they must be suitably cleaned. Shot blast carbide surfaces to be brazed before cleaning. Foil braze alloy may need mechanical abrasion to remove oxidisation prior to brazing. In the final step, clean all parts using alcohol in an ultrasonic bath and allowing to air dry. Do not use highly acidic or alkaline cleaning media.

Correct flux choice is imperative to achieving good quality joints. Flux removes surface oxides on carbide surfaces and prevents oxidation during heating. Figure 2 shows the importance of using flux. Select a flux in conjunction with the alloy, advice can be sought from braze alloy suppliers.

Do not use highly acidic or alkaline cleaning media. These can damage the superhard segment and cause premature failure.

Figure 1

Examples of segment/pocket relief styles



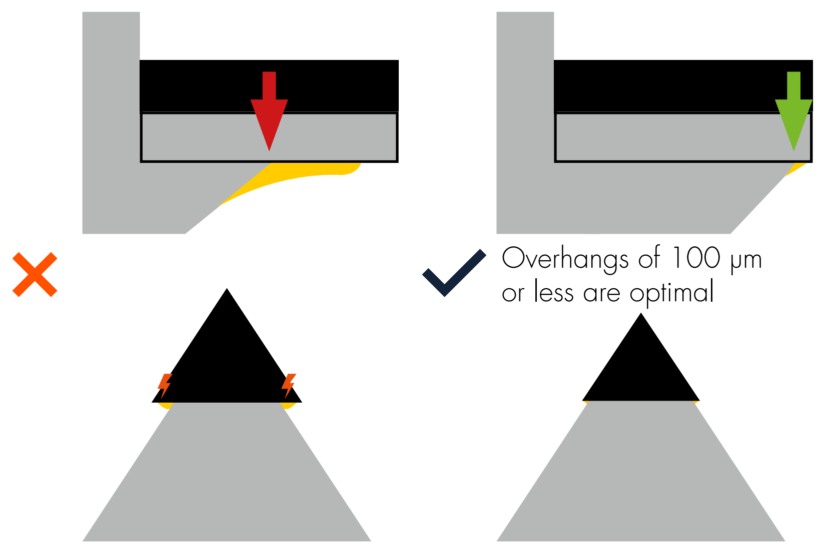


Figure 2

Examples of the importance of using flux.

With flux applied, the braze alloy has flowed across the WC surface well and maintained it's colour due to no oxidisation. Without flux, the alloy has oxidised and gone dark in colour. While simply shrinking and sitting on top of the WC surface because no chemical reaction has taken place.

With flux　　Without flux

Heating and cooling

Prior to heating, careful assembly of clean parts is required. Once the parts are cleaned, do not touch them with bare skin. Assemble using gloves or tweezers. Hold the tool body appropriately (dependent on tool type), often utilising custom-made jigging. Coat all the surfaces of the joint in flux, starting with the pocket in the tool body. Don't forget to coat the braze alloy itself, then the bottom surface of the superhard segment. (Note: if using paste, flux is often combined with alloy for easier assembly. Please check with your supplier).

Place tools to be brazed on a suitable insulating bed. If using a vacuum furnace, a portable holder is required for transfer to the furnace. If using induction or resistance heating, ensure access during heating using insulated tweezers as the segment may move.

Figure 3 shows a generic heating cycle, where the flux enters its working temperature just prior to the braze alloy becoming liquid. Once at peak temperature, hold for ~5-10 seconds to allow the alloy to flow throughout the joint. Longer soak time may be needed on larger joints. During this hold period, it may be helpful to move the segment slightly using tweezers to promote flow.

Once heating is complete, carefully move the tool to a suitable location to cool. Do not actively cool the tool in any way, such as quenching. Leave to air cool or submerse in sand.

Once cooled, clean the brazed part in warm water, brushing off any residue. Do not chemically clean. Avoid bead or grit blasting as these can damage the superhard segment.

A visual inspection should be performed post-brazing and cleaning, looking for: cracking, chipping, delamination, good braze flow, uniform braze thickness, voids in the braze and segment alignment. Figure 4 shows some examples of bad brazing.

Figure 3

Standard brazing cycle, suitable for non-active brazing alloys

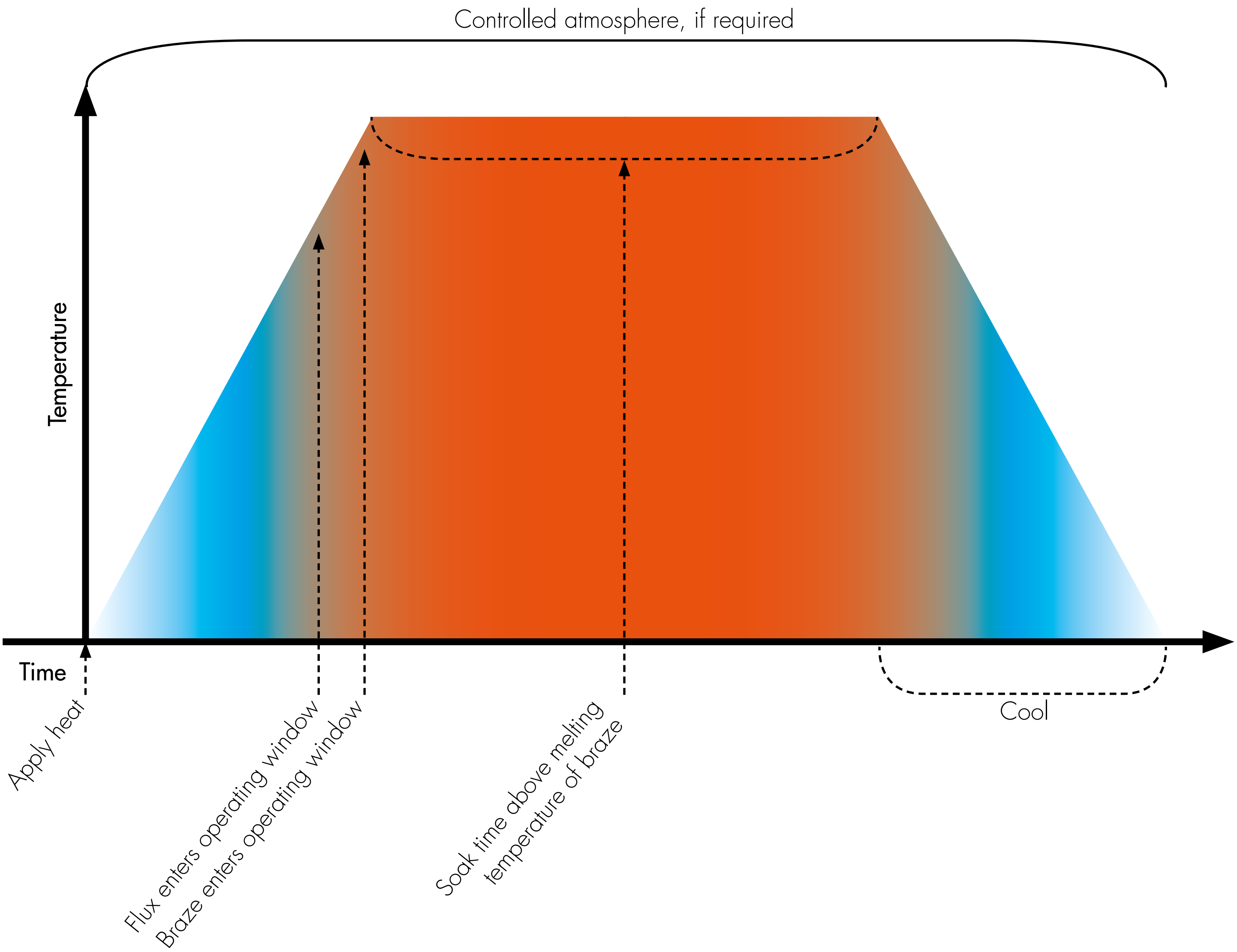
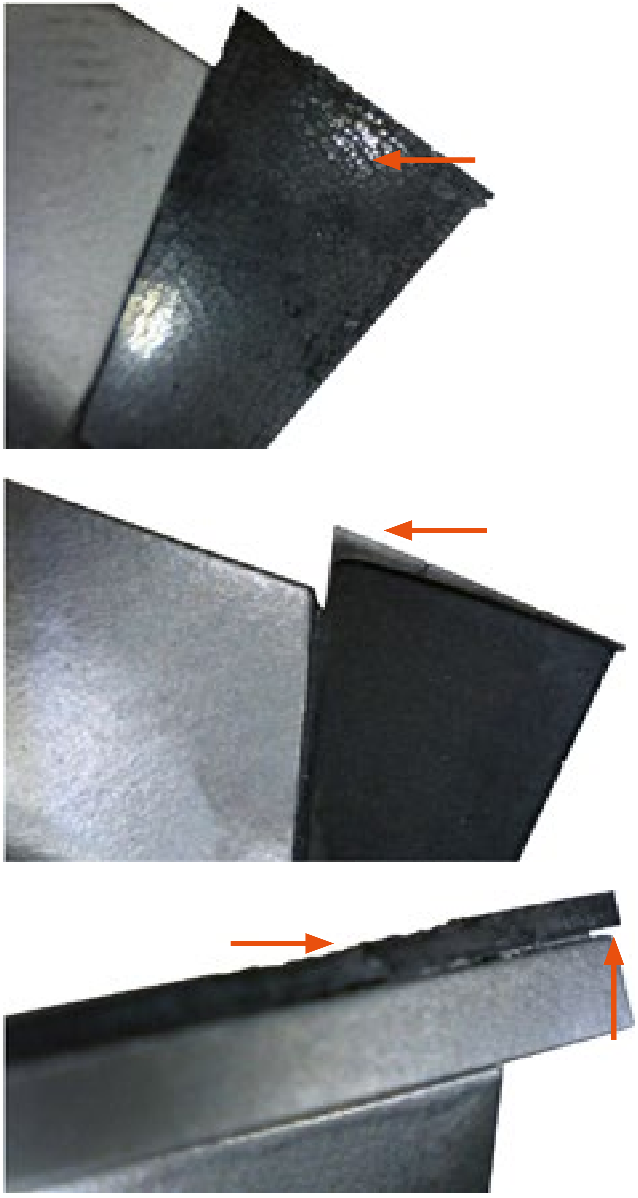
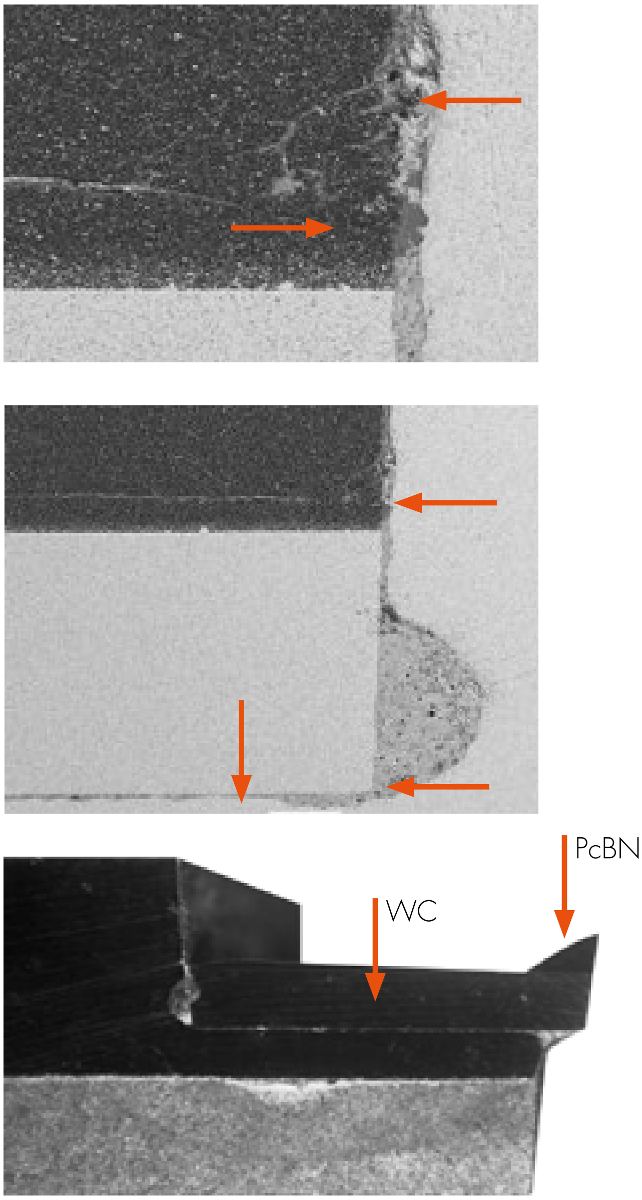


Figure 4

Examples of bad brazing



Left: graphitised PCD



Right: cracks and de-lamination of PcBN

The results

A well-designed brazing process should repeatedly produce a good quality braze joint. It can't be stressed enough that attention to detail, and ensuring clean surfaces, are key to a successful brazing process. Work with your braze alloy supplier to check the details of your process in conjunction with the braze alloy selected as well as your requirements. Although the superhard segment is the key focus, it shouldn't be a limiting factor on achieving a repeatable manufacturing process. By following the steps detailed in this case study, alongside working with your braze alloy supplier and with Element Six, superhard materials can be brazed without any issue.

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