



# SINGLE CRYSTAL DIAMOND FOR PRECISION TOOLS PROCESSING GUIDELINES

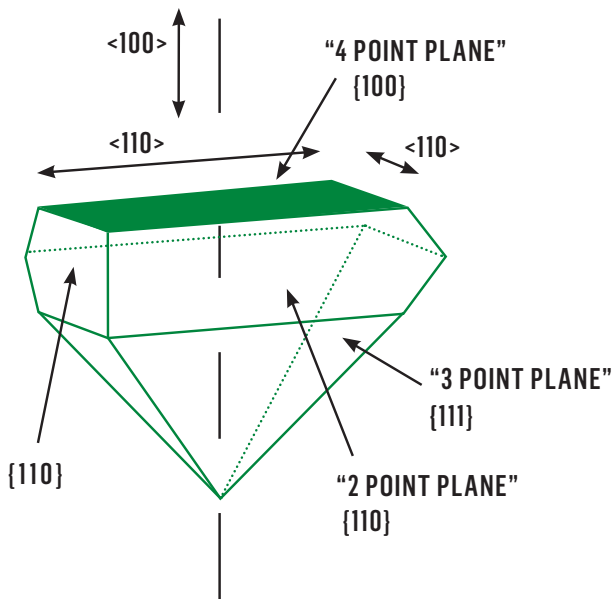
——— *Our synthetic single crystal diamond range provides exceptional wear resistance and extended tool life in precision applications. We recognise that the key to unlocking synthetic diamond's full performance potential is optimized processing – this guide has been designed with that in mind, to provide the necessary process parameters.*

*These guidelines are intended to be informative but by their very nature are general. You are strongly advised to seek advice from a trained professional and ensure the appropriate safety precautions are carried out before undertaking any of the activities described herein. Element Six cannot accept responsibility for any loss or injury arising from reliance on anything set out herein.*

# PREPARING THE DIAMOND SURFACE

## UNDERSTANDING SYNTHETIC SINGLE CRYSTAL DIAMOND ORIENTATION

Understanding the planes and directions in an octahedral crystal allows ease of processing:



The ease of material removal is determined by the “easy” and “hard” directions in the planar symmetry of the diamond shown below and differs between different crystallographic planes.

**MATERIAL REMOVAL RATE IN THE EASY DIRECTION:**  
12 : 6 : 1

**MINIMAL REMOVAL RATE IN THE HARD DIRECTION**

## PARAMETERS AFFECTING MATERIAL REMOVAL RATE

	STOCK REMOVAL AND ROUGH LAPPING	FINISH GRINDING AND POLISHING
Wheel type	Metal bond	Resin bond
Grit type	Micron+ MDA Micron+ CDA	Micron+ MDA Micron+ CDA
Grit size	15-20 $\mu\text{m}$	5-8 $\mu\text{m}$
Grit concentration	150-200	150-200

Scaife polishing = spinning a cast iron wheel with micron diamond grit.

- When shaping diamond using scaife polishing: use a low in-feed of grit with a flat wheel, and continually redress the wheel
- With this method a surface finish of  $R_a < 1 \text{ nm}$  is possible

## SINGLE CRYSTAL FINISH CONSIDERATIONS

The key to the success in processing synthetic diamond is lowering material removal rates.

Factors that minimise subsurface damage include:

- Processing direction – less damage induced along easy axes
- Grit size & grit concentration – resulting in reduced damage for lower sizes & concentrations
- Pressure & vibrations in the process – avoiding these will decrease damage

To achieve a non-planar geometry, extra caution is advised when crossing orientation lines during processing; form errors may appear due to a variation in removal rates.

# OPTIMIZING THE BRAZING PROCESS

## PREPARING YOUR SINGLE CRYSTAL DIAMOND

**KEEP THE DIAMOND INTERFACE CLEAN FOR SUCCESSFUL BRAZING.**

These steps should be followed\*:

1. Acid clean the surface to remove residue
2. Boil in distilled water for 5 minutes
3. Ultrasonically clean in isopropanol
4. Rinse in cool distilled water
5. Braze as soon as possible and do not handle with bare hands

## CREATING THE OPTIMUM BRAZING CONDITIONS

It is advised that the following conditions are adhered to when brazing your diamond\*:

- An active braze, typically containing Ti
- A protective atmosphere:
  - A vacuum ( $10^{-4}$  mbar)
  - Inert atmosphere ( $N_2$ , Ar)
  - Reducing atmosphere ( $H_2$ ,  $N_2/H_2$ , Ar/ $H_2$ )

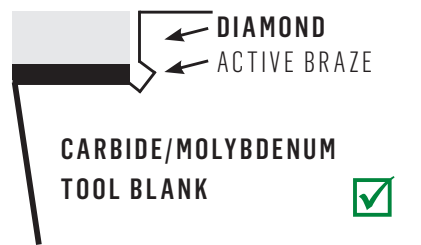
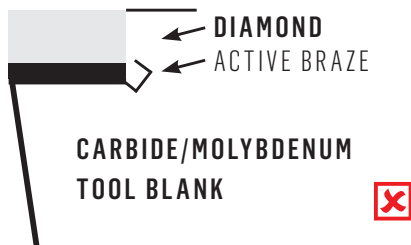


\* Please ensure you follow all safety recommendations in your brazing application.

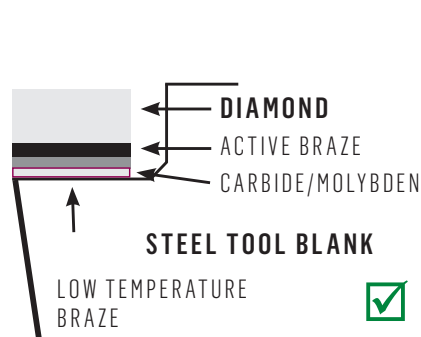
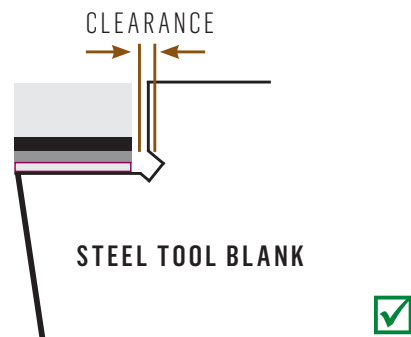
## POSITIONING TO AVOID FRACTURE DUE TO DIFFERENCES IN THERMAL EXPANSION



*Avoid large overhangs to stop fracture during cooling.*



*Direct contact between the back wall and the single crystal should be avoided.*



*To braze to a steel blank, an interlay is required.*

**THERMAL EXPANSION OF DIAMOND IS 10 TIMES LESS THAN METAL.**

## **ELEMENT SIX**

Element Six is a synthetic diamond supermaterials company and a member of the De Beers Group of Companies.

Element Six designs, develops and produces synthetic diamond supermaterials, and operates worldwide with its head office registered in Luxembourg, and primary manufacturing facilities in Germany, Ireland, South Africa, US and the UK.

Element Six supermaterial solutions are used in applications such as cutting, grinding, drilling, shearing and polishing, while the extreme properties of synthetic diamond beyond hardness are already opening up new applications in a wide array of industries such as optics, power transmission, water treatment, semiconductors and sensors.

If you would like to know more about Element Six please visit our website [www.e6.com](http://www.e6.com) or contact us at the address below.

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