OPTIMUM STAMPER BACKFINISHING AND PUNCHING

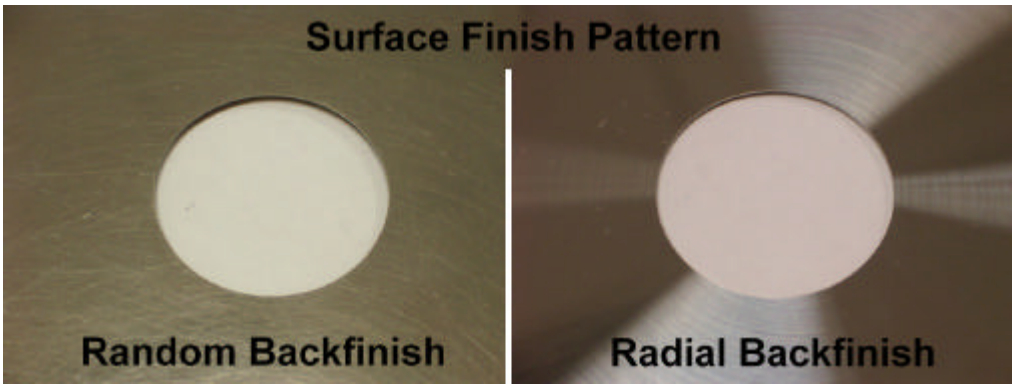
As the density of the Optical Disc increases, it becomes more and more critical to accurately replicate the pit structure during the moulding process. This in turn places greater demand on backfinishing and punching equipment along with the techniques required.

In the strive for the optimum backfinished and punched stamper, key critical factors must always be considered, **Rear Side Surface Finish**, **Surface Finish Pattern**, **Stamper Flatness** and **Stamper Thickness Variation** for backfinishing, and **Punched Hole Size**, **Punched Hole Roundness**, **ECC**, **Punched Hole Geometry, Stamper Deformation** and **Punch & Die Lifetime** for punching.

The most critical aspect of **Rear Side Surface Finish** is consistency across the stamper surface. CD and DVD specifications are typically Ra0.10µm - Ra0.07µm, whereas for recordable formats, a better finish from Ra0.05µm - Ra0.03µm is required. Surface scratches are measured as Rt, which is typically specified as Rt0.6µm for DVD, and below for high density formats.

To achieve an optimum **Rear Side Surface Finish**, a wet finishing process should be used. The consistency can be very precisely controlled by means of an X-Y platform and program. The flexibility of the polishing equipment will also allow the abrasive disc to 'dwell' over selected areas of the stamper to provide the optimum surface finish parameters required. Different diameters of polish can also be programmed using the operator touch screen.

With the optimum level of surface finish established, the **Surface Finish Pattern** must be considered. It is possible to create a random or radial pattern using the Sibert SPS-finisher, although the latter can affect the signal from the pit structure.



Different **Surface Finish Patterns** can be achieved by controlling the X-Y platform on the SPS-Finisher. For a random finish, an X and Y movement is used, whilst for specialist radial requirements, an X only, linear move is employed. Bespoke patterns for R&D can also be achieved by utilising the flexibility of the software.

Stamper Flatness is becoming more critical. Stress 'locked' within the electroformed stamper is released during the backfinishing process. Excessive deviation can prevent the stamper from being loaded onto the mould, and pockets of air trapped behind the stamper can create excessive movement of the stamper. Air trapped near the ID of the stamper may escape, creating small pimples in the polycarbonate.

Stamper Flatness can be greatly improved by controlling the finishing cycle time to a minimum. A careful selection of head pressure, feed and cycle time can be employed to keep the finishing process to a minimum. By dwelling the abrasive disc over selected areas of the stamper, flatness can be easily controlled.

Stamper Thickness Variation is controlled by the electroforming process to typically +/- 2.5µm. It is not possible to rectify this with backfinshing equipment. Firstly, the shape of the moulded replica is determined by thickness, and secondly, without it, the temperature on the surface of the stamper will not be uniform.

The backfinishing equipment does not influence **Stamper Thickness Variation**, as the backfinishing process can be very precisely controlled to create a very consistent result.

The **Punched Hole Size** is controlled by the punch & die size and greatly influenced by stamper hardness. Historically, a tolerance of <10µm was acceptable, now < 5µm is being demanded.

Control over **Punched Hole Size** can be improved by punching the ID hole as a separate operation. In a combined ID/OD setup, the ID cutting part remains in the stamper centre hole during the OD punching operation, potentially influencing the punched ID hole. By separating the ID & OD punching procedure on the SPS-Punch, this effect can be completely eliminated.

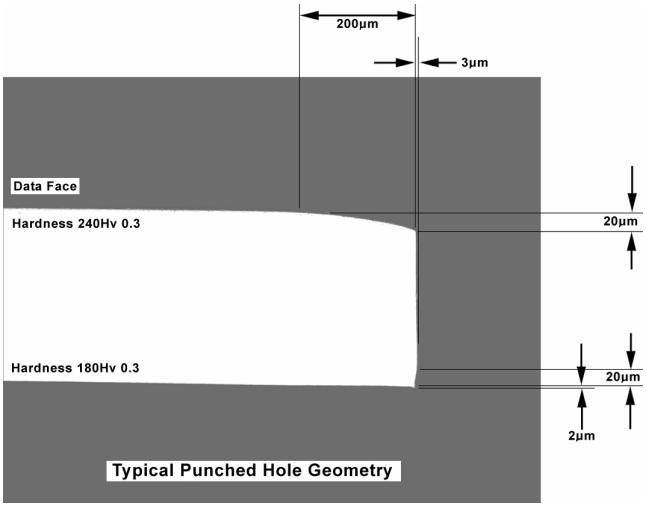
Punched Hole Roundness is controlled to <3µm by precise alignment of the upper and lower part of the punch & die set. Any misalignment will create an oval hole and consequently issues in moulding.

With the introduction of an improved alignment system on the SPS-punch, the use of a removable alignment tool has been eliminated. A sprung loaded ID die stripper also incorporates an alignment 'V' for greater accuracy. This part remains fixed in the tool, eliminating any error during punch & die change, and thus maintaining optimum **Punched Hole Roundness**.

The **ECC** of the punched hole is very critical for quality replicas. Historically, <20µm was deemed acceptable, but now values down to 3µm are being demanded for high density formats.

Improved **ECC** can be achieved by the upgraded punch & die alignment system. Enhanced optics with improved illumination creates an improved image contrast, which in turn allows the image capture software to track the data band more efficiently.

The **Punched Hole Geometry** is of increasing importance to prevent damage to the stamper holder in the mould. A deformed area of <200µm is normally permitted around the ID hole. This is greatly affected by the physical property of the stamper and the protective coating used on the data face, and is controlled by punch and die clearance.

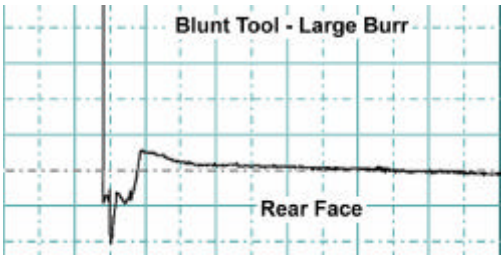


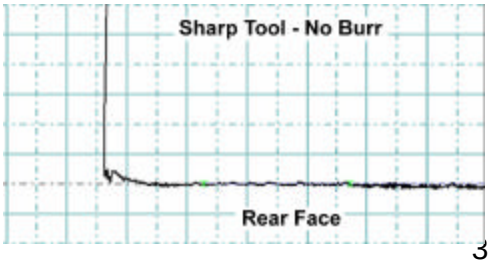
It has been proven that punching with protective coating, where the ID area is clear, can create the optimum **Punched hole Geometry**. This has the benefit that the centre area is clear whilst the data area remains protected. A simple hand-held application device can be used for aligning both the stamper and the pre-punched tape.

Stamper Deformation can be either a general unflatness, or a localised dent. This can be created due to the forces exerted on the stamper during punching and a value of <300µm is normally specified. This feature is controlled by the stamper clamping method and stripper plates within the punch and die set.

By separation of ID and OD punch & die sets, a larger vacuum clamping area can be used to hold the stamper flat during punching. The critical relationship of heights between ID and OD cutting tools is also removed, thus allowing the stamper to remain flat during the punching operation. Independent stripper plates for both ID and OD also assist in reducing **Stamper Deformation.**

Once the criteria above have been optimised, the ongoing performance will remain stable provided the cutting parts remain sharp. The end result is also greatly influenced by the hardness and thickness of the material being punched. Regular maintenance, together with precise punch and die alignment, will increase the **Punch & Die Lifetime**.





Although the hardness of the stamper is controlled by electroforming, the hardness of the punch & die cutting faces can be increased by up to five times using Titanium Nitride (Tin) coating. This will greatly increase **Punch & Die Lifetime,** and lengthen the time required between punch & die maintenance.

For further detailed information and understanding, look out for the Sibert whitepapers on stamper backfinishing and punching, to be published shortly in One-To One.

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(Reference to SPS added 10/4/06)