WHITE PAPER – **STAMPER BACKFINISHING**

As the density and speed of the Optical Disc increases, especially with Blu-Ray, the moulding process becomes more and more critical in the strive to accurately replicate the pit structure. This in turn places greater demand on backfinishing techniques, and an even greater emphasis on the need for correct specifications of stamper geometry, physical makeup and characteristics.

In the strive for the optimum backfinished stamper, four key critical factors must always be considered. For some time there has been a focus on the **Rear Side Surface Finish** specification, with little regard to the **Surface Finish Pattern**. However, **Surface Finish Pattern** is also very important along with **Stamper Flatness** after the backfinishing process - another critical factor. Finally we must consider **Stamper Thickness Variation**, although little affected by the correct backfinishing process.

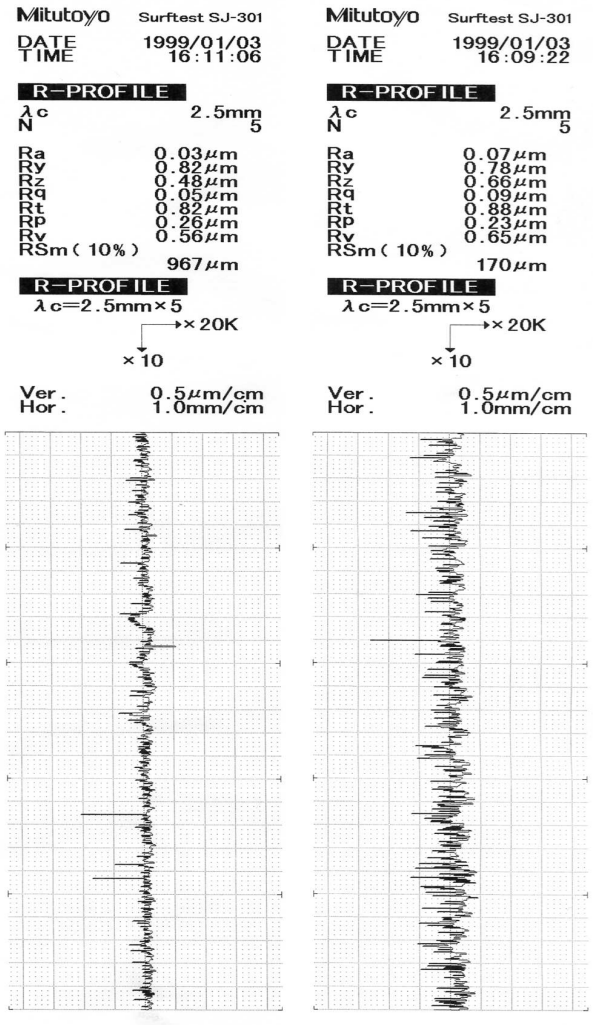
This article looks at each criteria in turn as follows: -

- **Rear Side Surface Finish**
- **Surface Finish Pattern**
- **Stamper Flatness**
- **Stamper Thickness Variation**

With regard to **Rear Side Surface Finish**, there are many schools of thought. The most critical aspect is for the finish to be consistent across the complete surface of the punched stamper. Any inconsistency may not allow the stamper to move freely on the mirror face of the mould as it expands and contracts during the heating and cooling process. As a result, problems such as clouding and electrical signal issues may occur. The surface finish values will determine what proportion of the stamper is in contact with the mirror face of the mould, and therefore greatly influence the heat transfer process. Obviously the more contact the stamper has with the mirror face; the quicker the transfer of heat is to the surface of the stamper. However, the level of surface finish needs to be carefully controlled, as too good a finish will create other issues, as described in the next paragraph.

With regard to the **Rear Side Surface Finish** specification, CD and DVD is typically Ra0.10µm down to Ra0.07µm, whereas recordable formats generally demand a better finish from Ra0.05µm down to Ra0.03µm, due the length of time the stamper is used in the mould. A specification lower than this is not beneficial to the replication process, as small pockets of air are required within the surface structure to allow the stamper to ‘breathe’ on the mould mirror face. If a mirror finish is present on both the mould and the stamper, the result of these two ‘similar’ finishes working together will be the stamper ‘wringing’ to the mirror face. This can cause damage to the stamper and the mould mirror face itself.

Another **Rear Side Surface Finish** parameter that is being measured for optimum process control is Rt. This measurement is the 'highest peak' of the surface profile to the 'lowest valley' and in terms of feature, would represent a scratch. Even if the Ra value were acceptable, one scratch within the data area would create an issue with the replica. A typical specification would be below Rt1.0µm with values down to Rt0.6µm for DVD, due to the higher density. Due to the fine pit structure in the case of Blu-Ray, this value must be even lower.



Fine Finish | Course Finish

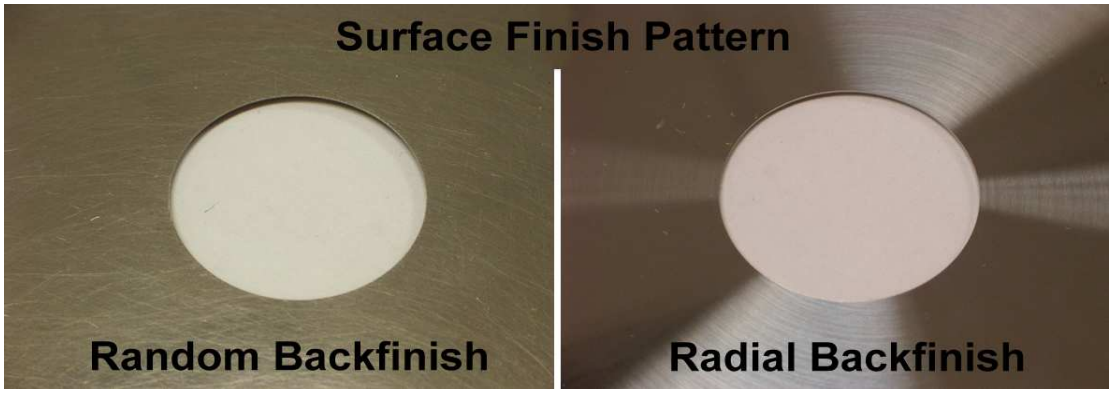
For optimum **Rear Side Surface Finish**, a wet finishing process should be used. The consistency can be very precisely controlled by means of an X-Y platform and program. The flexibility of the polishing equipment will also allow the abrasive disc to 'dwell' over selected areas of the stamper to provide 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. Due to the high pressure employed during the moulding process, there is a danger that any pattern or defect on the stamper

rear side will become transferred to the replica. This is especially true in the case of courser finishes, or if the surface finish value for the particular format being produced is incorrect.

The small surface scratches within a random pattern will generally cross the pit structure at a greater angle, creating less chance of influencing the signal, whilst a radial pattern will create the effect of a scratch running with, or at, a small tangent to the pit structure. This is far more likely to affect the signal from the pit structure.

If a radial pattern is present, the surface finish must be very good and at around Ra0.03µm to prevent any such issues occurring. This could have a negative effect on stamper life and replica quality. Another effect of a radial pattern, due to its regularity, is that during the stamper lifetime in the mould, small particles of nickel can wear off as the stamper moves slightly, creating small 'build ups' of nickel, which shorten the life of the mirror face.

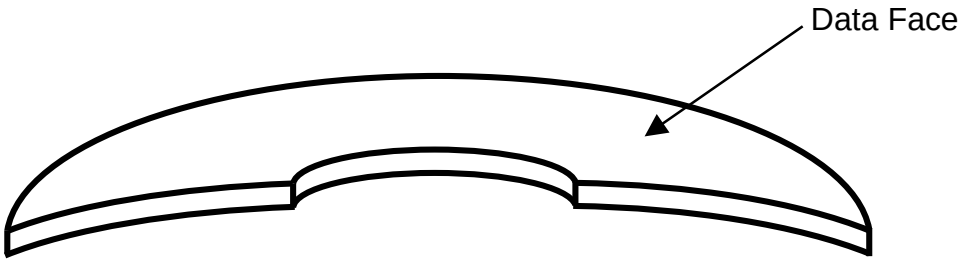


It is, therefore, normally recommended to employ a random **Surface Finish Pattern** on the stampers after backfinishing.

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 if desired, by utilising the flexibility of the software.

As the density of optical disc increases, **Stamper Flatness** is becoming more and more important. There are several factors to consider, beginning with the way the stamper is created and then through its subsequent processes. A nickel stamper by virtue of the way it is produced by electroforming, is a highly stressed object. Stress is 'locked' within the electroformed stamper, but stress known as surface tension will be released during the backfinishing process, creating unflatness. This is a result of the skin of the stamper surface being

removed. If the backfinishing equipment is set up and used correctly, this feature can be greatly minimised. Therefore, the combination of stamper property and process control will greatly influence the quality of the end result.



Stamper with Stress

Different backfinishing processes will create a different end result; a typical request from some mould manufacturers is 0.3mm deflection from ID to OD of stamper. Any excessive deviation can prevent the stamper from being easily loaded onto the mould, and once loaded there will be an excessive air gap between the stamper and the mirror face of the mould; this could create further issues. One issue that may be experienced if the stamper is not sitting flat, is damage to the leading edge of the pits as the replica pulls away. Excessive pockets of air that are trapped behind the stamper may expand due to temperature change and create movement of the stamper. This in turn can create ‘blur’ and ‘flow mark’ issues. Alternatively, if air is dispelled, uneven movement may occur in the stamper that will introduce uncorrectable digital signal errors. Localised air trapped near the ID of the stamper may escape between the stamper ID and the stamper holder creating small pimples in the polycarbonate known as ‘mount Fuji’s’.

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 must be controlled by the electroforming process. The total thickness variation (TTV) across the stamper is typically 5µm; this is becoming increasingly important for higher density discs. The optimum stamper backfinshing equipment should be designed to remove the high points from the surface structure whilst not interfering with the overall thickness profile. For a variety of reasons **Stamper Thickness Variation** must be controlled by electroforming. Firstly, the shape of the moulded replica is determined by it and secondly, without it, the temperature on the data of the stamper will not be uniform. This will create issues, as even small amounts of temperature change will affect the moulding process.

SPS – Finisher

For a variety of reasons if there is **Stamper Thickness Variation** present, it is not possible to rectify this with backfinshing equipment. As air within the polish head is compressible, the polish head will follow any unevenness in the stamper surface. The main factor is that the data face of the stamper must be protected during this process. The protective coating cannot be applied to the micron level of flatness that is required to accurately control the amount of material removed by backfinishing. The method used to create a flat and parallel component is known as lapping and works on a completely different basis. This, however, is prohibitive on a stamper due to the protective coating, as already mentioned.

Stamper Thickness Variation is not influenced by the backfinishing equipment, as the finishing process can be very precisely controlled to create a very consistent finishing process.

In conclusion, the **STAMPER BACKFINISH SPECIFICATION** is created from various criteria such as **Rear Side Surface Finish, Surface Finish Pattern, Stamper Flatness** and **Stamper Thickness Variation;** these must all be considered in turn if the correct specification is to be achieved.

Without this, it may be impossible to achieve the quality required on the stamper for high density formats.