SPS – *Punching*

As the density of Optical Discs increases, the demands placed on accuracy and equipment performance also increases. Therefore, in order to achieve the correct results and meet the latest high-density specifications such as **Blu-ray**, each individual manufacturing stage needs to be controlled more tightly.

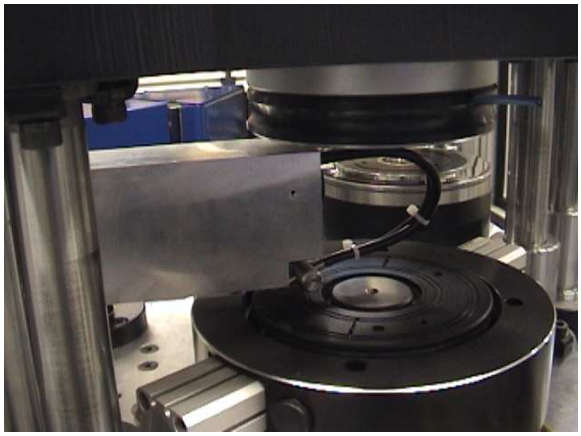
Sibert has always placed a high level of importance on the quality of stamper preparation processes prior to moulding and is responding to the new format requirements with its latest range of modular and upgradeable equipment, the **SPS - *Stamper Preparation System***. This has been specifically designed to increase the levels of control and automation during stamper preparation. One part of this system is the **SPS – *Punching*** module, which has been designed to include various improvements over previous machinery.

Key Features & Benefits:

- Separated ID & OD Punching Processes
- Improved Punching Mechanism
- Increased Stamper Support
- Improved Tool Alignment
- Software Controlled System
- Preventative Maintenance Control

Optional Upgrades:

- Automatic Centring
- Automatic Handling
- Automatic Transfer From Finishing



Key Features & Benefits Explained

Separated ID & OD Punching Processes

The **Punched Hole Size** is controlled by the Punch & Die cutting parts and also greatly influenced by stamper properties. Historically a 10 micron tolerance band was specified, but this window is now being reduced to 5 microns and even below, in the strive for greater accuracy. The size is controlled by two factors; the punch cutting diameter and the correct clearance between the cutting parts. This clearance is carefully calculated taking into account the thickness of material being punched, which must also include the protective coating being used. Any change therefore in thickness of stamper or protective layer will influence the end result. Stamper hardness will also affect the result; normally a harder stamper will produce a smaller hole, but due to other stamper physical properties there are exceptions to this rule. As the cutting parts wear the hole size will typically decrease by a few microns, so as with any cutting tool, regular maintenance is essential in order to maintain correct specifications for the type of fit required on the stamper holder.

Depending on the specific customer requirements Sibert offers both Standard and Reverse type punching methods, to further assist the moulding requirements. The **SPS – *Punching*** module improves control over **Punched Hole Size** by punching the ID hole as a separate operation. In a combined ID/OD set up, 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 this effect can be completely eliminated.

Improved Punching Mechanism

Another area that is becoming much more critical with the latest formats is the punched ID hole shape or profile, which is known collectively as **Punched Hole Geometry**. This is important because a stamper is a relatively thin piece of material. Therefore, the amount of vertical contact available from the sidewall of the ID punched stamper onto the shaft of the stamper holder is critical in achieving the correct amount of support required to meet latest stamper accuracy and lifetime requirements during moulding. As a by-product, improved **Punched Hole Geometry** also assists with a better quality fit onto the stamper holder.

The process of punching will always create a small deformation around the ID hole at the punch entry point. This deformation area can be greatly influenced by correct stripper plate design, tool wear, stamper hardness, stamper ductility, Punch & Die clearance and finally, protective coating material type and thickness. For example, a blunt punch & die set will create a greater deformation, whilst a hard stamper will reduce this. Punch & die clearance has to be carefully controlled as excessive clearance will create a large deformation as the material pulls into the hole. Also, it has been proven that punching with protective coating, where the ID area is clear, can improve the **Punched Hole Geometry** in terms of reducing the punch entry radius. This has the benefit of the centre area being clear whilst the data area remains protected. If the punch entry radius is outside the diameter of the lip on the holder, this can potentially cause irreparable damage to the stamper holder, the moulded polycarbonate disc not separating cleanly from the mould or a lip being formed on the polycarbonate disc creating bonding issues on dual layer manufacture.

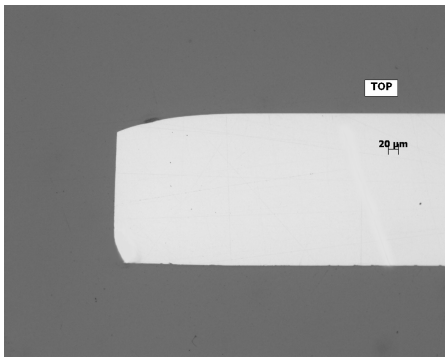
Given the importance of correct **Punched Hole Geometry** and to reduce the punch entry radius still further, the **SPS – *Punching*** module has introduced greater control and accuracy to the ID punching process.

Due to the separation of ID & OD operations, the OD punching system within the **SPS – *Punching*** module has remained a fairly conventional hydraulic process. However, to provide more control within the ID punching process, the **SPS – *Punching*** module is equipped with a new punching mechanism that provides a programmable increasing force during the ID punching action. This allows an optimum **Punched Hole Geometry** or entry radius to be achieved every time, as it allows each stamper to shear at its correct or optimum point.

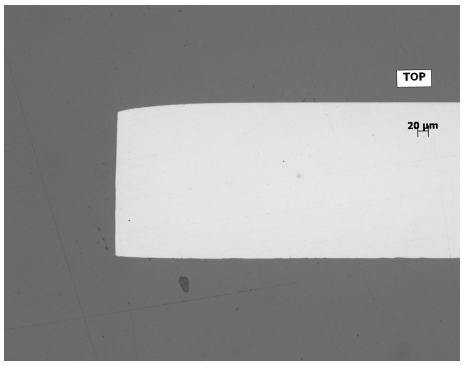
When compared against conventional punching performed on the same stamper, the entry radius improvement has shown to provide an average of 25 - 30% reduction in the horizontal plane, thus improving the contact area around lipped stamper holders. This improvement in turn, benefits the sidewall of the hole by reducing the curvature created at the top of the entry point, therefore allowing more of the punched stamper ID to be in contact with the shaft of the moulding spigot. This new mechanism can be adjusted to provide various speeds and pressures at the beginning and end of punching cycle.

Examples of conventional and **SPS – *Punching*** results performed on the same stamper shown as cross-sections at the ID hole.

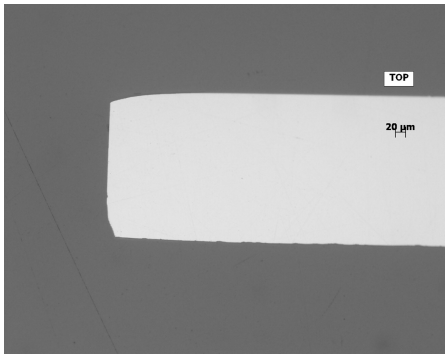
Conventional Punching
(with protective coating)



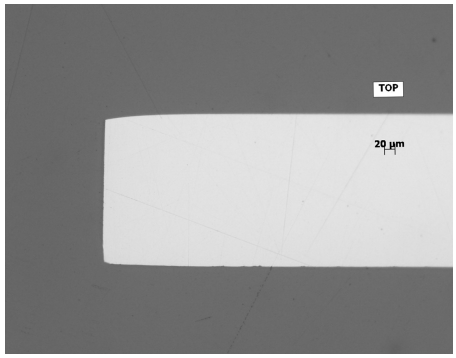
SPS – *Punching*
(with protective coating)



Conventional Punching
(without protective coating)

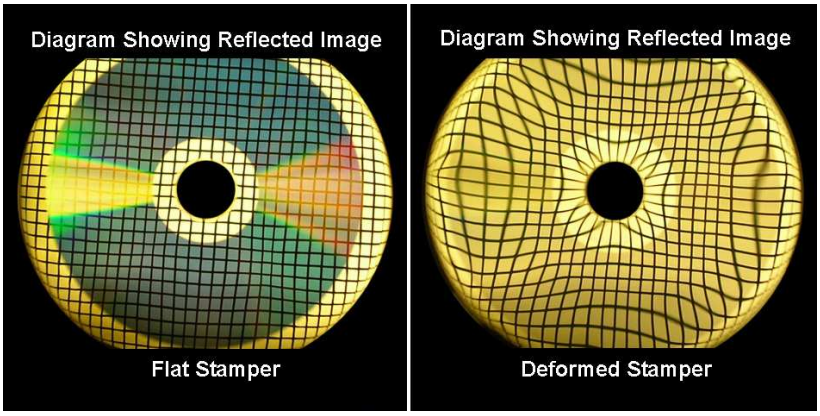


SPS – *Punching*
(without protective coating)



Increased Stamper Support

Due to the forces required during the punching process, the stamper is subjected to a lot of pressure. If not carefully controlled, this pressure can create excessive **Stamper Deformation,** which can take the form of either a localised dent or crease or an overall unflatness of the stamper after punching. This feature can greatly affect the clamping of the stamper in the mould, therefore potentially creating issues during moulding. Stamper flatness during punching is carefully controlled with the use of sprung loaded stripper plates and carefully designed heights of relative cutting and stamper support faces.



As with the **SPS – *Punching*** module, 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.**

Improved Tool Alignment

Punched Hole Roundness is another key area that must be controlled. The roundness of the punched hole is mainly controlled by the accuracy of alignment between the lower part, the die, and the upper part, the punch. Any misalignment between the punch & die will create an oval hole. Unroundness in the punched hole will influence ECC on the polycarbonate disc during replication, along with other issues involving excessive stamper movement on the mirror face.

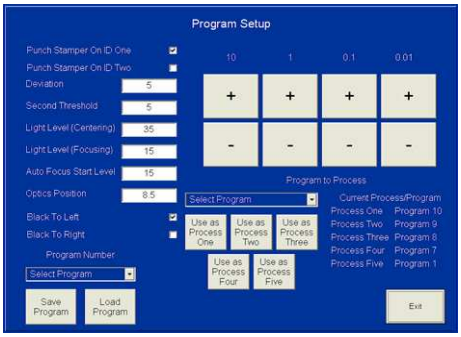
With the introduction of an improved alignment system in the **SPS – *Punching*** module, the use of a removable alignment tool has been removed. A sprung loaded ID Die stripper also incorporates an alignment 'V' for greater accuracy. This part remains fixed in the tool thus eliminating any error during fixing and maintaining optimum **Punched Hole Roundness**.

Software Controlled System

The software within the **SPS – *Punching*** module has been designed to provide the user with the ability to change or adjust various aspects of the machine in order to provide the correct set up for each stamper manufacturing requirement. This has also been designed to assist with the automation of the complete stamper preparation process, which is one of the key benefits of the **SPS – *Stamper Preparation System*** over previous equipment.

Some areas of programmable process control on the **SPS – *Punching*** module include:

- Adjustable light levels for automatic focusing
- Adjustable light levels for automatic centring
- Adjustable horizontal movement for automatic optical head travel positioning
- Image enhancement for BD and HD applications
- Adjustable punching start pressure
- Adjustable punching speed
- Adjustable punching end pressure
- 10 different stamper type programme memory



Preventative Maintenance Control

Once the optimum Punch & Die set up has been achieved, the quality of the punched stamper will be maintained provided the cutting edges remain sharp. The **Punch & Die Lifetime** is affected by the hardness and thickness of the material being punched as well as the accuracy of alignment between the punch & die cutting faces. Regular maintenance and cleaning will help increase the life of the cutting edge, thus allowing the optimum punched stamper results to be produced over an increased period of time.

The **SPS – *Punching*** module is also equipped with a Punch & Die change indication system that allows the customer to preset Punch & Die change warning indicators. These will illuminate on the touch screen display prior to the tooling reaching its optimum preset quantity, relating to hole quality and size acceptability from Sibert initial recommendation, customer specific stamper make up and moulding spigot design.