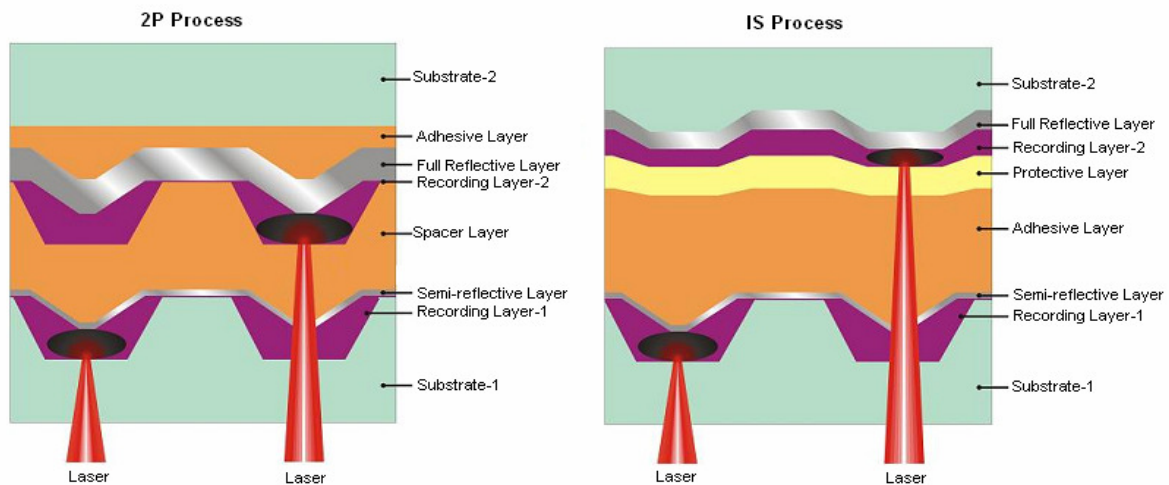


## Difference between 2P DL Disc and Inverse Stack DL Disc

### Introduction

The manufacturing process of DVD Dual layer discs requires additional production steps compared to single layer DVD+/-R discs. There are two different methods of manufacturing DL discs in use today: the 2P process and the inverse stack process (IS). The names are derived from the process used to define the second layer structure. 2P is an abbreviation for Photo Polymerization, the step where the groove of the second layer is defined in a UV-curable resin. The inverse stack process refers to the manufacturing of a disc where the substrate and the dummy are bonded together as in a single layer DVD disc, but where the dummy contains the second recording layer in which the sequence of applying the reflector and the dye material is inverted compared to the first recording layer. In this white paper we describe the manufacturing steps of these two processes and a comparison between the two in terms of manufacturing and efficiencies.

Figure 1: Schematic Layout 2P and IS



### 2P DL Manufacturing Process

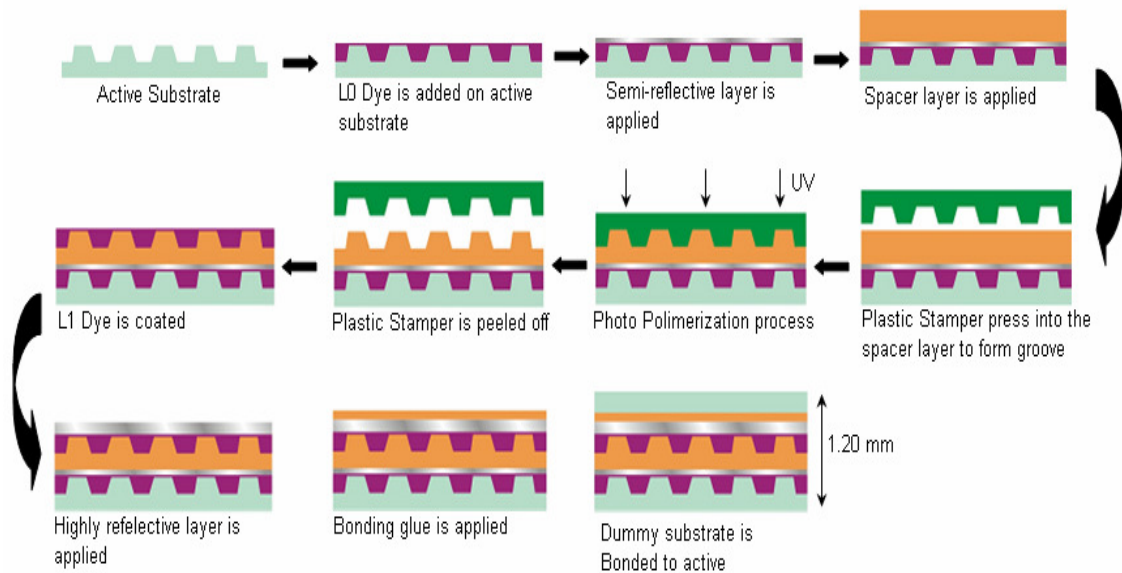
The 2P manufacturing process is shown schematically in Figure 2. The first 4 steps are basically identical to those for manufacturing of a single layer DVD+R or DVD-R discs. A substrate with a groove made by injection moulding is covered with a dye and a thin metal layer. The dye and reflective layer are semi-transparent to enable the laser beam for recording or reading to access the second layer. Step 5-7 shows the use of a transparent substrate (the “plastic stamper”) with a grooved structure (green) to define the recording groove of the second layer by photo-polymerization (2P). The transparent stamper is made by injection moulding and is pressed into the spin-coated spacer of UV-resin.

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The spacer is subsequently hardened by photo-polymerization under the curing effect of an ultra-violet light and the groove structure of the stamper is copied into the spacer. The stamper is then peeled off from the hardened spacer. The next step is coating of the second recording layer L1 consisting of a 2<sup>nd</sup> dye layer and a 2<sup>nd</sup> reflective layer. The rest of the manufacturing process is similar to that for regular DVDs: the recording half is bonded to the upper dummy blank to complete what is referred to as a DVD dual layer disc (Figure 2).

Figure 2: Manufacturing steps of 2P Dual Layer Process

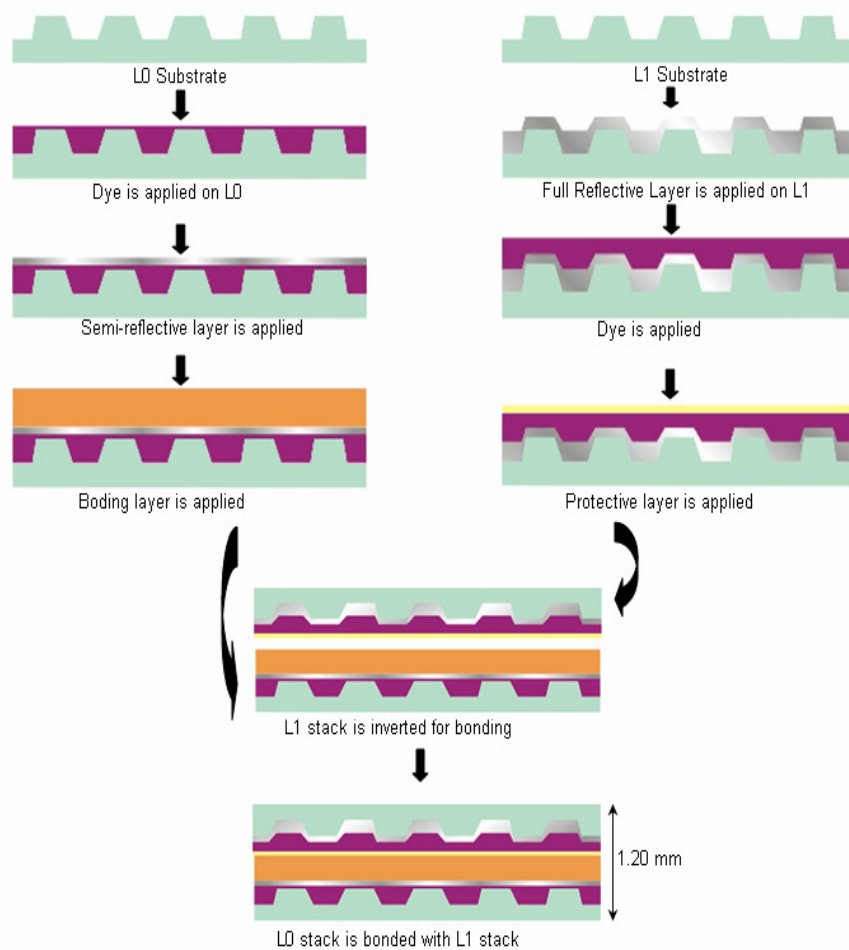


### Inverse Stack DL Manufacturing Process

In the inverse stack manufacturing process for DL DVD disc, the dummy substrate is used to make the second recording layer. The fabrication process is depicted schematically in Figure 3. Groove is replicated in this dummy by injection moulding and the recording stack is applied on this grooved dummy. After that the substrate with the first recording layer L0 and the dummy with the second recording layer L1 are bonded together. UV curing of the resin is done through the transparent L0 recording layer and special care has to be taken to ensure a uniform thickness of this bonding layer without optical defects like bubbles as this bonding acts as the spacer between the two recording layers. In manufacturing L1, the sequence of the layers in this second recording layer is inverted: first the metal reflector is sputtered, than the dye layer is applied. For the L0 layer (and in standard DVD SL discs) this is opposite: first the dye layer than the reflector, see figure.... The manufacturing process name Inverse Stack is derived from this layer inversion in the second recording layer. From manufacturing point of view the inverse stack process is more elegant and straightforward than the 2P process. In inverse stack no plastic stamper is needed and only one process for groove replication is used: injection moulding. However, the dye coating process on the L1 layer in IS requires special attention compared to dye coating of L0 or of SL discs. For L0 the dye should predominantly be present in the grooves: no or

little dye is needed on the land as the recording takes place in the grooves. For L1 the recording in IS DL discs takes place on the lands of the grooves in the dummy substrate, as these are closest to the laser entry side of the disc, see Figure 3. Typically this requires the grooves of L1 layers in the IS process to be more shallow than the grooves in L0, to enable coating of the dye on the lands. Secondly the dye for L1 is coated on the metal reflector instead of on polycarbonate. This requires special dye materials, dye preparation and coating for the L1 layer in the IS process. Simply put: in 2P discs, grooves in L0 and L1 are deep and dye recording material is predominantly present in the grooves, whereas in the L1 layer of IS DL discs, grooves are shallow and dye is present on both land and groove, see Figure 3.

Figure 3: Manufacturing steps of IS Dual Layer Process





### **Drive compatibility of 2P and IS:**

Both layers of 2P are similar in groove shape and dye coverage. Each of these layers behaves very similar to standard DVDR SL and thus the drive tuning is more or less straightforward. In IS discs, the shallow groove and the difference in dye coverage at L1 require special tuning for write strategy and groove tracking. Due to this difference between 2P and IS, any default write strategy designed for 2P discs will not work on IS disc in drives where a particular inverse stack MID code is not supported. Note that FTI IS discs have passed format verification which ensures that our discs can be written correctly with any drive that meets the format specification requirements.

### **Productivity and Yield:**

2P process involves two replication techniques; moulding and UV replication and thus the process is more complex. During UV replication a plastic stamper is used and that needs to be peeled off after replication of L1 geometry. This makes extra production cost due to the wastage of plastic stamper. Inverse stack process is more similar to standard DVDR SL production. Manufacturing of both layers stacks proceeds in parallel up to the adhesion process, so it enables a high volume production and yield. Since L0 and L1 stack are manufactured independently and adhered at the end of the process, the testing precision can be dramatically improved.

### **Conclusion**

The construction of a Dual Layer is complicated. Reflectivity, transmission and absorption of both recording layers must be balanced. FTI work with technological leaders, partners and customers to use their extensive R&D capabilities and optical disc manufacturing experience to develop and optimize each layer structure and produce functioning 8.5GB single-sided DVD+R DL media. The dual layer media made with inverse stack method at FTI have undergone exhaustive testing and are certified by the Philips Format Verification Laboratory. Certification provides drive manufacturers and end users with the assurance that FTI's DVD+R DL media delivers broad compatibility with new drives and as well as DVD playback devices and have fully compliant and supporting firmware and software.

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