Production Equipment
For
DWT Device Manufacturing Process Line
Presented to: RPO
Canberra, Australia

Introduction

FAS is pleased to present this quotation for production equipment for the RPO DWT device production manufacturing process line designed to match RPO's specification for production of digital wave guides on Polycarbonate substrates.

The extrusion coater will be manufactured by FAS and will meet the specific requirements presented by RPO in technical discussions related to the DWT Device Manufacturing Process Equipment Line and is designed to accommodate RPO's nominal substrate size of 400mm x 500mm. The coating width of the system will be approximately 390mm, and the desired coating area on the substrate will be 390mm x 490mm. The system will be designed specifically for RPO's UV curable polymer, incorporating a superfinished die to provide high quality coatings for this application.

The FAS extrusion coater is delivered as a stand-alone tool, designed as a manually loaded production system. The extrusion coater will be designed so that it can be readily upgraded into a fully automated tool, integrated with the other process equipment tools to facilitate fully automated substrate handling throughout the proposed device manufacturing process line.

Extrusion Coater:

The FAS extrusion coater has three (3) major areas of modification to meet the RPO production specification:

1) Custom Vacuum Chuck
2) Automated Substrate Load/Unload Station
3) System Enclosure
1. Custom Vacuum Chuck:

The coater system is designed to accommodate RPO’s flexible plastic substrates (175 micron thick polycarbonate). These substrates will be coated as single panels and will not be mounted on a rigid or semi-rigid frame. The vacuum chuck will be manufactured from granite but will differ from our standard chucks in that a higher density of vacuum holes will be used to secure the flexible substrate; a bonded aluminum manifold will be used for vacuum distribution. The chuck will be designed with a flotation-based load/unload feature that is compatible with the RPO manual end effector (substrate handler). The load/unload station will be conceptually similar to the motorized system initially developed for RPO, but without the motorized movement and generally simplified for cost-down objectives.

2. Automated Substrate Load/Unload Station:

This station is designed to operate in conjunction with the custom 400mm x 500mm flexible substrate chuck. It includes a lift pad assembly that rises to interface with an end effector (attached to a separate delivery device, such as an MGV) so that a substrate can be transferred between the two. The lift pad assembly then lowers into, and becomes a part of, a fixed air flotation table and guide system that is used for the automatic loading and unloading of the substrate onto or off of the vacuum chuck. The guide system of the load / unload station includes features to ensure the proper alignment of the substrate during the transfer and securing operations. The load / unload station will use clean, humidified air (CHA) to float the substrate, and the station will include the necessary controls and monitoring devices to maintain the required vacuum, pressure, humidity, and flow for the system to function.

3. MGV (Manually Guided Vehicle) and Docking Station

The MGV is designed to provide a manual guidance system for loading and unloading a substrate at each process tool in the manufacturing line, and to provide a safe and secure means of transporting a substrate between process tools (including temporary storage buffering between processes). The MGV includes an end effector designed to properly locate and align a substrate to the substrate transfer mechanisms present at each process tool in the manufacturing line. The MGV also includes linear positioning stages that allow the substrate to be moved in the horizontal and vertical planes as needed during that process. Precision motion stops and sensors will be used to ensure that the substrate / end effector are properly positioned during transfer operations at each tool. A docking station will be located at the substrate loading end of each process tool in the manufacturing line. The docking station provides a repeatable and precise means of locating the MGV at each tool once the MGV and docking station are engaged. The docking station also includes features that provide for the controlled, automated vertical positioning of the MGV horizontal linear stage and end effector. Each docking station will be in a fixed location and dedicated to a specific tool; however, each MGV will be interchangeable with every docking station so that a single MGV could be used to load / unload substrates at every tool and transfer substrates between them.
4. System Enclosure:
The FAS extrusion coater will feature an isolation enclosure around the process area. The enclosure will be attached to the isolation plate and will provide vertical walls on 4 sides for personnel protection from the moving carriage. The enclosure will have interlocked access doors on 2 sides for operator access and service, and a door for substrate load access. Ionizer bars will be mounted both above the open top enclosure, and at the substrate load / unload port to control static charge build up on the substrate. The enclosure will be constructed of anodized aluminum and powder coated steel, along with Marguard Lexan panels and doors. The Lexan panels are also treated with a static-dissipative coating on the interior and exterior faces, to improve cleanliness and static charge control. EMO buttons will be located on opposite corners of the enclosure. For controlling the solvent vapors from the RPO process, the enclosure will be designed to have a slightly negative pressure balance vs. the surrounding cleanroom. Exhaust ports will be located on the isolation plate to provide general enclosure exhaust and the negative pressure bias for solvent vapor control (RPO will provide facilities exhaust connections). The enclosure is not designed for flammable solvent vapors; RPO agrees to use combustible solvents in the system, or agrees to revisions in the scope of the enclosure design including system safety features, if it is determined that flammable solvents must be used.

Additional RPO Extrusion Coater Custom Features

Coating Die will be custom for the RPO IPG material. Final die requirements will be determined somewhat in parallel with system build, based upon ongoing development work between FAS, RPO, and Allied Die. Die will potentially include the following features. FAS and RPO agree to discuss altering the quote pending the final die design, should the scope of the die design change significantly.

- Super-polished die internal wetting surfaces
- Die lip flats increased to 500 microns width
- Add 50 micron deep outer recess to die to allow clearance of edge bead on underlayers. 1mm wide nib between die cavity and outer lip relief. Greater than 50 microns relief would be even better.
- Increase all fluid path orifices;
  - ID 8mm tubing
  - Change solenoid valves to AMD 312-10BUS-8
  - Redrill all POH and die openings to 0.25” I.D.
- Add PI pressure monitoring extrusion die manifold assembly, designed for high viscosity fluids, 0-14.5psi.
- Add DataQ data logging system.
- Software modification to allow positive and negative values for “offset from coat height”. -500 micron offset currently used at coat start.

Notes on RPO extrusion coating process, and related equipment modifications:

- RPO coat fluid requires low die heights during coating
  - 30 micron die height for core layer
- 50 micron die height for buffer and cladding layers
- Basic rule is ‘die height’ = ‘film thickness’ + 10 microns
- Vacuum manifold as delivered on original Advantage 3 does not provide a worthwhile improvement in coating performance and will not be included on this system.
- Viscoclastic properties of IPG coat fluid – software modifications to allow a two stage prime would be beneficial. FAS agrees to modify the system for a two stage prime.
- RPO currently does not use the NowPak system for intermediate reservoir refill. However experience on SSEC spin coater with direct NowPak dispense has shown that an inline degasser is vital to obtain bubble free operation with RPO fluid. RPO have had good success with Superphobic membrane contactor degassers from Liquicel. Degassers should be assumed for all future tool purchases. RPO will provide degassers for the systems to assure commonality of parts and performance proven models. Also this contributes towards cost-down objective of the system.
- Standard calibration procedure for Omron height sensors is impossible with viscous coat fluid present in die cavity. Auto calibration system will be needed on next tool purchases. FAS agrees to equip the coater with the new design Keyence sensor, with auto calibration feature.
- Substrate load flotation system has been successfully tested but with minimal ability to compensate for misalignment of substrate relative to end effector. This needs to be considered in final production design. In addition, the current cassette design uses corner locating rods for substrate positioning – is this sufficient? FAS agrees to work with RPO to implement a lower cost version of the load station, with adequate alignment (refer to previous comments on Custom Vacuum Chuck).

Additional requirements from meeting in Dallas January 2010:

- Software should have ability to open head vent at end of coating. FAS agrees to add this capability.
- Use die pressure set points (rather than time) for PD prime. FAS agrees to work on the development of this capability, but this is not a strict requirement at the time of shipment. RPO agrees that this can be added as an upgrade after delivery of the tools.

Additional requirement February 2010:

- Increase POH volume for buffer and cladding layer coating – system will be equipped with a 15ml POH.
- Add in-line humidity sensor on CHA line.
Photograph of Standard FAS AD2 Coater