Maintaining Gap and Parallelism between Slot Die Coater Head and Media in Liquid Coating Applications

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Extended Abstract

The presentation will cover an assessment of the advantages of various technologies used in measuring gap and parallelism between the head of a slot die coater and the metal roll supporting the media in a variety of liquid coating applications. Capacitec has 20 years experience supplying non-contact slot die coater gap uniformity systems achieving repeatable coater gap uniformity better than 10 microinches (0.25 microns) in applications such as thin films, adhesive labels, batteries and flexible solar panel coatings. Coating machine manufacturers and end-users have asked Capacitec to develop a slot die coater head to metal roll media carrier parallelism measurement system for several years as they have been unsatisfied with non-electronic measurement tools such as feeler gauges and other types of contact mechanical gauges.

Capacitec will be introducing the new Slot Die Coater Head to Media Gap and Parallelism Measurement system used as a pre-process set-up tool as well as the latest development in the quest to use embedded non-contact sensors as an in-process tool during production. Typical applications include the production of Organic PV Panels, Flexible Solar Panels and other high technology applications such as flexible displays and medical diagnostic media. These tools are used to reduce material and labor cost, boost yields and improve quality.

Organic Photovoltaic Solar Panels (OPV)

According to SpecialChem "Organic photovoltaics (OPV) is an innovative solar cell technology based on conductive plastic materials such as polymers. Such devices are fabricated by ultra low-cost, roll-to-roll printing techniques. They are formed by layering extremely thin, photo-active coatings on lightweight, flexible carrier substrates, which are organic in nature as well. OPV is one of the most dynamic, rapidly developing technology segments pertaining to renewable energy in the future. Organic photovoltaics could enable large-scale solar energy generation directly integrated in roofs and facades."

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[1] Unpublished. ISCST shall not be responsible for statements or opinions contained in papers or printed in its publications.

Although they are ultra low cost, commercially available OPV modules currently provide output efficiency of between 3 to 5 percent which is much lower than other solar panel technologies such as CIGS, CdTe and silicon based that offer 10 to 15%+ output efficiency. Process Engineers at OPV flexible solar panel manufacturers are therefore seeking new ways to improve total module output efficiencies through process improvements.

Capacitec is working with key players in both the US and European OPV market to enhance their multi-layer liquid coating process by offering a more accurate non-contact slot die coater head to metal roller gap measurement system to replace current methods.

Figure 1: OPV solar modules on roof of tent

Current Mechanical Gap Measurement Methods

Engineers have found limitations and major reliability problems with traditional contact gap measurement methods. Shims and feeler gauges have marginal accuracy when the tolerance required is better than 25 microns. Once the gauge is removed from the gap after set-up there is no way to be sure that the gap is still within specification. Plastic shims can vary in thickness by 7.6 microns and feeler gauges show different results from operator to operator. The accuracy of contact measurement methods is reduced over time. The constant rubbing against hard surfaces during the measurement process causes wear on the shims and feeler gauges, and can also damage the highly polished surfaces found in applications such as slot die coaters and roller to roller gaps.

Parallelism of Slot Die coater head to media

During OPV (Organic Photovoltaic) panel fabrication, a slot die coater gap measurement system is used to maintain organic material coating uniformity. Capacitec non-contact parallelism systems are used to maintain parallelism between the slot die coater and the metal roller.

This is accomplished by installing two model HPC-150 non-contact displacement sensors onto special fixtures on both ends of the slot die coater head “looking” at the centerline of an electrically grounded roller. A voltage output proportional to the air gap dimension from both HPC-150 sensors to the roller is signal conditioned through the Capacitec electronics. The resulting air gap is then further processed through Capacitec Bargrafx® software for further linearization and display. The display graphically shows whether the slot die coater is parallel to the metal roller. This gap can be adjusted before liquid coating operations of the OPV layers.

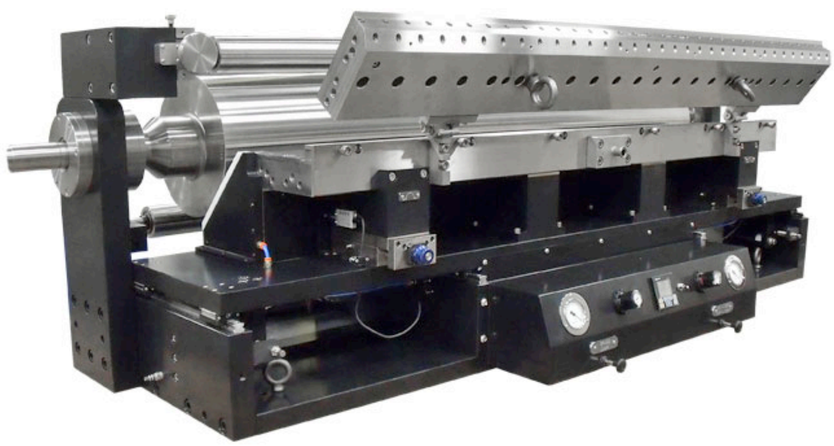

Figure 2: Parallelism system for Die Coater Stations
*Photo Courtesy of Premier Dies

Slot Die Parallelism in coating flexible displays and medical diagnostic media

During the coating process of flexible displays and medical diagnostic media air gaps are currently set between the slot die coater head and the metal roll holding the media with the use of feeler gages. As mentioned above, contact feeler gage methods are subjective, less accurate and abrasive to polished surfaces. In addition to these limitations, feeler gages cannot be effectively used for gaps below 50 microns due to their excessive malleability.

As the trend in flexible displays and medical diagnostic media coating is requiring thinner coating thicknesses the challenge becomes how to accurately set and maintain the parallelism between the coater head and metal roll to less than 50 microns.

Capacitec is addressing this need with the supply of small diameter threaded or circular non-contact displacement sensors installed on a custom end bracket on either end of the slot die coaters to set the parallelism between the coater head and roller during pre-process and possibly in-process control.

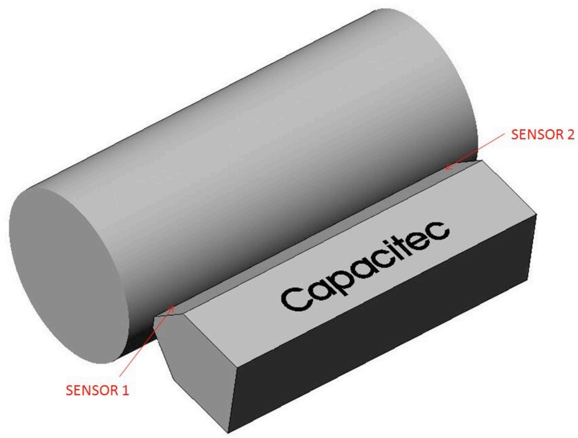

Figure 3: *Parallelism measurement for air gaps below 50 microns*

The two non-contact capacitive displacement sensors read the air gap change relative to each side of the metal roller. With this information operators can raise or lower either side of the slot die to adjust for microinch (nanometer) level parallelism.

The Capacitec Bargrafx® software also offers a set-to-standard option to facilitate the setting of the air gap parallelism. In this case the roller to slot die lip could be leveled to a fixed dimension such as 300 microns. These readings could then be saved in the Bargrafx software and used to determine when the parallel air gap is at the specified air gap such as 40 or 50 microns. This system eliminates the need for reliance on less accurate feeler gages to set very thin gaps when coating very thin layers onto flexible displays and medical diagnostic media.