Kurt J. Lesker Company is introducing a unique optical coating system incorporating the Isoflux Inverted Cylindrical Magnetron (ICM) with a unique substrate carrier configuration designed to provide features presently unavailable in any marketed coating system. The combination of the Isoflux ICM with the design of the KJLC precision optical coating system results in a deposition tool capable of providing high quality coatings with unprecedented flexibility of operation, all in a package with an unrivaled simplicity of design from John Morris Scientific.

The Objective Optical coating is one of the largest segments of the coating industry and many effective tools are available for applying these coatings, including evaporation tools as well as sputtering tools. Regardless of the technology used, one of the greatest challenges for high precision coatings is the ability to coat substrates of different curvatures with high degrees of uniformity.

Conventional techniques require the use of custom masks for each different geometry, which requires a system breakdown for each substrate geometry change as well as a complex trial-and-error development process to establish a new mask for a new geometry, even something as subtle as a slight change in curvature.

The goal of the KJLC system was to build a tool capable of providing the highest quality optical coatings with unparalleled flexibility—a tool capable of simply and easily coating various substrate geometries with coating recipes that virtually eliminate changeover time between batches.

In addition, the unique design of the Isoflux ICM enables the deposition of coatings of equivalent quality to ion assisted deposition but without the need for a separate ion source, simplifying the construction and operation of the system while reducing cost and complexity.

The Heart of the System The heart of this novel coating system is the Isoflux Inverted Cylindrical Magnetron (ICM) cathode, which sputters from the inside of a cylinder to enable extremely high quality coatings with the adaptability of coating different substrate geometries from concave to flat to convex with no masking and zero changeover time. The key to the system is that the substrates to be coated are placed off-axis with respect to the target rings.

Figure 1

The substrates to be coated are placed off-axis, as shown in Figure 2. The cathode employs a patented unbalanced magnetic field geometry, represented in Figure 2 by the red arrows in the image. The unbalanced magnetic field is a key in the function of the ICM in this off-axis configuration. As the sputtered atoms are accelerated and leave the end of the cathode to reach the substrate, electrons cut across the magnetic field lines and follow. As the electrons leave the end of the cathode, they draw positive ions along with them which bombard the substrate, providing a degree of ion bombardment without incorporating a separate ion source.

Figure 2

In tests performed by Isoflux, direct measurement of the ion bombardment at the substrate surface was comparable to the ion flux generated by other ion-enhanced processes, but without a separate ion source.

Indices for optical coatings prepared by this method are comparable to the indices measured by other ion-enhanced coating options, as shown below in Figure 3. The line on the plot shows the index of an optical coating prepared using the Isoflux ICM, whereas the individual data points represent literature values of coatings prepared by other ion enhanced methods, as labeled and indicated in the graph. The coating prepared with an ICM source, even without incorporating a separate ion source, was comparable to the coatings prepared by the other techniques.

Figure 3

Unparalleled Substrate Flexibility The truly unique capability of the system comes from its ability to coat different geometries without incorporating any masking and to convert from one geometry to another with no changeover time whatsoever. That unique feature is enabled by the ICM’s geometry combined with the off-axis placement of the substrate.

When coating off-axis in an ICM, uniformity is dependent upon the placement of the substrate with respect to the z-axis of the cylinder. That location is critical for good coating uniformity, and shifting the location of the substrate with respect to the cathode can provide good uniformity for different curvatures.

As shown below in Figure 4, moving the substrate location up and down (as indicated by the green arrows) allows the user to dial in the ideal location for a particular substrate geometry. Flat surfaces are placed just outside the racetrack of the bottom target. Convex surfaces are placed further up into
the cylinder, whereas concave surfaces are placed further out from the cylinder.

Figure 4
This unique feature, combined with the moving platen system designed into the precision optical coater, allows for a simple adjustment by the control interface to handle flat, concave, and convex parts in the system without breaking vacuum.

Overall System Configuration The overall design of the system incorporates two ICM cathodes—one for a high index material and one for a low index material, along with a three position material handling system. The two cathodes are shown on the overhead perspective of the body of the system seen in Figure 5.

Figure 5
The basic configuration of the system is shown below in Figure 6, with the load lock labeled on the front of the system. The load lock may be flush mounted for access through a clean room wall, saving expensive clean area square footage and simplifying maintenance to the main system from common access areas of the facility.

Figure 6
The material handling system is located within the domed portion of the vacuum system, and includes three positions—one for the load lock, and one for each cathode. Each platen of parts is approximately 12 inches in diameter and is designed to hold up to four 125 mm parts or sixteen 50 mm parts in each of the three platens. At any given time, the system could contain up to twelve 125 mm parts or forty-eight 50 mm parts.

In addition, the system is designed to sputter both cathodes simultaneously, so that at any given time, the system could be loading parts in the load lock in one position, while a high-index coating is being applied in one cathode and a low-index coating is being applied in the other cathode.

Furthermore, since the software allows independent control of each cathode and each platen, the system is capable of coating a different substrate geometry on each platen as well as a different coating stack on each platen.

It is possible to load one platen of flat parts, one platen of convex parts and one platen of concave parts in the system at the same time, and to apply a different coating recipe to each platen. The unique flexibility of the system is ideal for high mix product lines or for products where high degrees of uniformity are necessary on non-flat substrates.

Uniformity The table below (Figure 7) demonstrates the theoretical uniformity achievable on different substrates with different degrees of curvature. The alpha build unit will be tested to provide comparative data to these models

Figure 7
To find out more about Optical Coating Through Combinatorial Magnetron Sputtering, please contact our team of Vacuum experts by Email: vacuum@johnmorris.com.au
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