Precise contract coating for consumer electronics applications

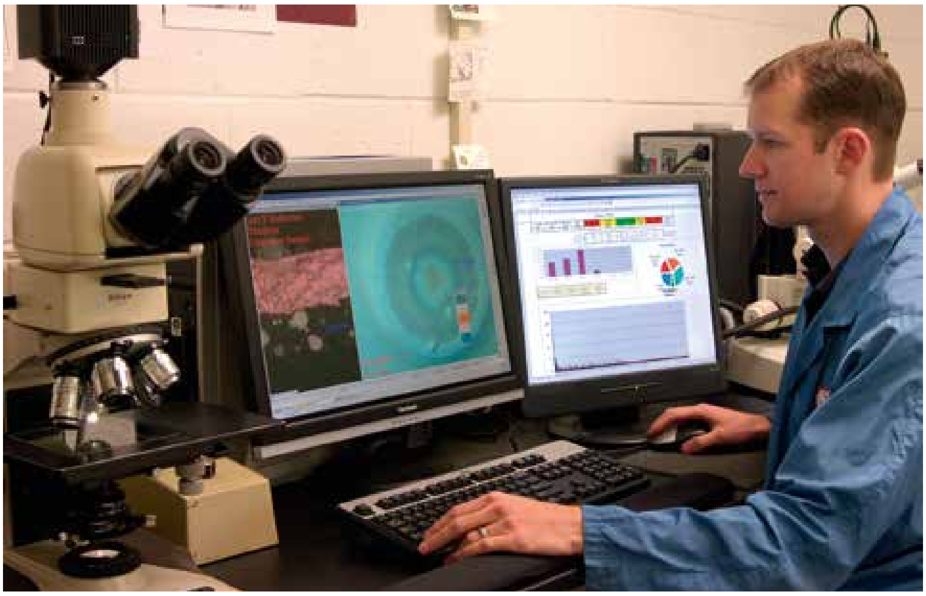
Brian Pahl, business development manager, and Corinne Ladous, technical account manager at Carestream Contract Manufacturing discuss working with a contract coater to manufacture advanced electronic films

The market for displays, touchscreens, and other consumer electronic devices is constantly evolving due to the demand for smaller, more powerful, lower-cost and longer-life products. Part of the development process for these devices involves the formulation of very precise coating and casting materials and technologies to enable a range of functions.

Precision, multi-layer coating is ideally suited for many of today's electronics film applications as coatings can be applied to substrates to achieve optical properties or other attributes in finished products. These film coatings supply various engineered properties such as barrier qualities, selective permeability, reflectivity, conductivity or other attributes. Advanced coating materials can also be applied in different layers, each meeting a unique purpose. Qualified contract coaters can create multilayer, precision structures, with options for two-sided coating, radiation cure, in-line inspection and lamination in the same machine pass to deliver a rapidly growing variety of electronics products including transparent conductive films, hard-coated optical films, optically clear adhesives, photoresist films, and barrier films.

Working with a qualified coating partner

Developing and manufacturing electronics films requires a coating partner with extensive materials and process expertise, strict project management and quality controls, and the tools to bring leading edge, precision-coated products to market.



A variety of inspection techniques, including optical microscopy, microtome cross-sectioning and SEM imaging with elemental analysis, allow quick identification of defects

Contract manufacturers with experience developing advanced coatings can help determine the proper formulation, estimate development timeline and implement rapid prototyping methods to efficiently scale-up to production. A well-conceived prototyping process can enable companies to notice design errors and other issues that could later cause significant problems – ultimately saving time and money.

When working with a coating partner, begin by discussing new product concepts early in the development stage when coating formulations, coating methods and product structures can be modified at lower cost and minimal schedule impact. The contract coater should offer concrete strategies to improve economics and to make the process more robust, while meeting or exceeding quality needs.

Once the application is discussed, the contract coater will generally outline a process involving benchwork, pilot testing and full-scale production trials, and will estimate the development timeline and costs. In the benchwork phase, the contract coater's technical team will apply knowledge of solution properties such as rheology, and substrate attributes like surface energy, to determine optimal coating methods and conduct small-sample testing. This step culminates in a go/no-go decision and an initial project plan outlining fluids and coating technologies for evaluation.

Next, the product scales up through a series of pilot coating trials, testing a range of coating solutions and conditions. Data from these trials is typically analysed collaboratively to construct the best possible plan for each subsequent trial. The optimal process conditions for transitioning to commercialisation are identified during bench and pilot evaluations. The coating conditions developed on the pilot line are verified or adjusted for larger-scale production. Once the product meets all key requirements, the process is finalised and fully documented.

Requirements for electronics films

Creating high-quality electronics films involves numerous complex variables and stringent quality guidelines, which require proper metrics and film quality inspection methods. As a result, projects should involve a rigorous production release test, specialised to meet the stringent optical and cosmetic requirements of electronics films. These exacting guidelines include quality inspection, extensive analytical testing and clean-room practices.

The latest electronic devices use multiple layers of optical grade films that contribute a range of functional properties to the device

Quality inspection: Sophisticated 100% inline quality inspection and process control techniques optimised to meet high-end electronics films enable the coating process to run continuously while monitoring and controlling deviations that would negatively affect product performance. Best-practice inspection techniques help to identify and characterise contaminants, minimise anomalies and defects, and ensure uniform thickness control for high productivity and high yield processes.

While quality inspection techniques depend on the material, electronics applications commonly require sophisticated optical inspection systems that scan across the web. The ideal system is designed to detect objects much smaller than the defect size limit for the product. When implementing optical inspection methods, inspection can be reflective or transmissive with dark field and bright field results. Another consideration with optical inspection is the angle of incidence between light source and the inspected web material. Optimising incidence angles and correlating multiple inspection methods enable anomalies to be spotted in the web.

In coating a clear product, for example, a dark field inspection might be performed with the signal reflected because dark particles and clear gels will reflect light differently. By using multiple channel (bright field and dark field/transmissive and reflective) inspection methods, technicians can gain a good understanding of any defects and begin to characterise and correct them.

Contract manufacturers provides expert staff for process design, commercialization and rigorous quality system implementation

Analytical testing: Many advanced electronics films combine multiple functionality in one film construction, including thermoset adhesive films; membranes for haptic, acoustic and vibration dampening applications; multi-layer composites with optical, electrical and mechanical properties; and optically clear adhesives. These films must be designed and tested to ensure the favourable properties of each function are maintained as additional layers are coated or laminated onto the construction. To accomplish this, advanced testing and analytical techniques are required from product design and scale-up through commercialisation and finished product testing of every part.

Coating scientists focus on three main areas to ensure impeccable quality of finished materials: raw materials' incoming quality control (RM IQC), materials characterisation and quality assurance. All three functions are interconnected and performed throughout the product development process.

Chemists design unique methods to enable analytical quantification of key quality requirements for a variety of custom electronics products. Optical image analysis techniques are frequently adapted to analyse product images for particle size, number of particles, circularity and other values. Additional quality testing metrics for electronics film products include haze, transmission, film thickness, uniformity, optical clarity and density, colour, index of refraction, reflectivity and opacity – to name just a few. Each factor plays a critical role in meeting specified characteristics and performance stipulations on a product-by-product basis.

Testing equipment enables the evaluation of an immense range of material properties with precision. For example, interferometers, X-ray fluorescence (XRF), micrometers, gravimetric analysis and cross-sections are used to measure coating thickness. Optical properties are analysed with HazeGard for haze, transmission and clarity. Additionally Fourier transform infrared spectroscopy (FTIR) and scanning electron microscopy (SEM) are used for organic and elemental analysis. SEM can also be used for high-resolution imaging to assess film morphology and its impact on performance.

Clean-room practices: To meet the stringent optical and cosmetic requirements of electronics films, clean-room production areas are a must. Materials produced in Class 100 clean rooms during all production phases prevent the introduction of contaminants that can affect quality and clarity. In addition, it is important that incoming raw materials and packaging materials are designed to prevent contamination of the product. Clean-room practices keep point defects, debris and imperfections to a minimum – resulting in higher yields for electronics films and other advanced materials applications.

Conclusion

In closing, contract-coating manufacturers with established coating processes and experience with the unique demands of electronics applications can readily apply their existing process tools to a wide variety of electronics products. By utilising a contract manufacturer's proven coating methodologies and advanced rapid prototyping capabilities, customers can dramatically change manufacturing design processes and reduce cost of manufacturing. The result is more efficient and economical scale-up of electronics products from benchtop to production.