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Vacuum Deposition onto Webs, Films, and Foils

Charles Bishop
C.A. Bishop Consulting, Ltd.

BISAC Code: TEC040000 • TECHNOLOGY / Technical & Manufacturing Industries

ISBN13: 978-08155-1536-4
Specs: $190.00 • 6 x 9 Hardcover • 650 pages • **©2006 • November 2006**

High resolution cover art at:
http://www.williamandrew.com/resellers/bishop.htm

"**Vacuum Deposition onto Webs, Films, and Foils** is a comprehensive reference work for anybody working in vacuum coating of polymer films. The book contains detailed sections on all aspects of this technology, from the vacuum itself to the coating process, from winding to troubleshooting. The author has many years experience in the field, and it shows."
Dr. A.G. Spencer - Alacritas Consultancy, Ltd.

"This new book is **THE source** for persons interested in roll-to-roll vacuum coating. The author displays a breadth of experience and a wealth of knowledge. The material is well organized, refreshing, comprehensive, and accessible. Experts will learn many new things, and newcomers can avoid numerous pitfalls."
Dr. Donald J. McClure - 3M Corporate Research Materials Laboratory

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This new book from William Andrew Publishing is ***the only practical reference available*** for anyone employing the roll-to-roll deposition process. **Vacuum Deposition onto Webs, Films and Foils** is an expansive journey of the process; benefiting manufacturing efficiency, unit cost reduction, and financial results. It is a sweeping approach to the total design of the vacuum deposition process written by a successful and world renowned consultant with three decades of experience.

Roll-to-roll deposition processing is a high growth industry and this reference covers a wide variety of important industrial products that use vacuum deposited coatings, including: optical storage devices, metallized packaging films, energy conservation windows, electronic information displays, and magnetic electronic article surveillance (EAS) tags among many others. This book is **a must-have** for roll-to-roll machine operators, process engineers, and research and development engineers throughout industry.

The book provides a broad appreciation of roll-to-roll vacuum deposition systems and processes. It will encourage a more comprehensive look from material supply through to the downstream processes that the product will encounter. It is a truly unique reference written to guide operators and engineers as an onsite consultant would.

Section I: Vacuum Basics.
What is a vacuum? • What is a gas? • Pressure • Partial Pressure • Vapour pressure • Saturated Vapour Pressure • Why do we need a vacuum? • Mean Free Path

2. Products using vacuum deposited coatings
Metallized packaging films • Capacitor films • Optical data storage (ODS) tapes • Holographic coatings • Flake Pigments • Transparent barrier coatings • Transparent conducting coatings (TCOs) • Energy conservation windows • Solar cells • Solar absorbers • Flexible circuits • Optical variable devices (OVDs) • Magnetic electronic article surveillance (EAS) tags • Pyrotechnics • Thin film batteries

3. Pressure Measurement
Bourdon gauge • Pirani & Thermocouple gauges • Capacitance Manometer • Penning or cold cathode ionisation gauge • Ion or hot cathode ionisation gauge

4. Pumping
Rotary or Roughing pumps • Rootes pumps or blowers • Diffusion pumps • Turbomolecular pumps • Getter or sputter ion pump • Cryopumps • Pumping strategy • System pumping

5. Process Diagnostics & Coating Characteristics
Reflectance (R), Transmittance (T) & Absorbtance (A) measurements • Optical Density • R,T, & A measurements • Conductivity / resistivity • On-line resistance monitoring • Transparent conducting coatings • Residual Gas Analysers (RGA) • Plasma Emission Monitors (PEM) • Thickness • Barrier • Neural Network control systems • Chemometrics • Surface energy measurements • Emissivity

6. Leaks, water vapour and leak testing
Real leaks • Imaginary leaks • Outgassing & Water Vapour • Leak Detection

7. Mass spectrometers, Helium leak detectors & residual gas analysers.

Section II: Substrates, surface modification and nucleation
8. Substrates - surface quality, cleaning - adhesion & adhesion testing
Substrates • Polymer Surface quality • Substrate Cleaning • Surface Etching • Metal web & surface quality • Metal surface contamination • Paper • Foams, non-wovens, textiles • The 'Sellotape' test • Adhesion tests • Cores • Packaging

9. Surface treatment of webs & foils
Cleaning & Sealing • Cleaning • System design considerations • Polymer coating basic information

10. Nucleation, coalescence & film growth.
Thin film – Thick film • Nucleation • Coalescence • Network & percolation threshold • Holes • Film growth • Energy • Electrical & Optical performance • Crystal Structure • Deposition rules of thumb

Section III. Process
11. The D.C. Glow Discharge or Plasma
The Townsend Discharge • The Breakdown Voltage • The Transition region • The Normal Glow Discharge • The Abnormal Glow Discharge • The Arc • Triodes and Magnetically enhanced plasmas

12. Electron beam (e-beam) evaporation
Filaments and electron emission • E-beam control • Power supply • Crucibles and feed systems • System design

13. Thermal evaporation
Boats • Wire feeding • Wire • Spitting & Pinholes • Thin film measurement • Power supplies & control • Coating uniformity

14. Radiant heated and Induction heated sources
Radiant heated sources • Radiation shields • Induction heated sources

15. Chemical Vapour Deposition / Polymerisation onto webs.
Substrate temperature • Power • Pressure • Substrate bias • Fluorinated plasma polymerisation • Carbon - Fluorine plasmas • CVD of Barrier coatings

16. Planar Magnetron Sputtering source design and operation.
D.C. planar magnetron sputtering source • Balanced and Un-balanced magnetron sputtering • Anodes • Radio Frequency (RF) sputtering • Arcing and control of arcs • Water-cooling • End effects • Troubleshooting magnetron sputtering sources

17. Planar magnetron design options.
Single or Dual magnetron sputtering source • Anode included or not? • Balanced or unbalanced magnetic fields • Fixed or variable magnetic performance • Internal or external fitting • Direct or indirect cooling • Single or multiple materials • Linked or isolated cathodes • Cost implications • Coating uniformity • Magnets

18. Reactive deposition – set-up & control
Target preconditioning • Control options • Hysteresis loop • Monitors • Time constants • Pumping • Control of arcs • RF sputtering

Section IV: System issues
19. Machine specification & build issues. - Risk Analysis - process.
Risk Analysis - process • Mistake-proofing or Fool-proofing • Project Management • Safety • Costs • Machine specification • Maintenance & spares

20. Heat load on the webs/foils.
Introduction • Potential winding problems • Characteristic winding problems associated with too much heat • Heating webs

21. Process variables
Drum surface roughness • Polymer surface roughness • Material properties • Deposition rate and winding speed • Water content of polymer • Drum temperature • Single or double side coating • Source type • Heat load calculations • Heat transfer coefficient

22. Mechanical design
Pumping • Non-Uniform pumping • Shields

23. Winding webs in vacuum
System design • Tension measurement – load cells • Alignment & roll spacing • Materials • Related items & materials • Substrates – variable width & tension • Key points on winding • Safety

24. Metallizer machine building trends
Metallizers • Speciality machines

25. System design
System choices • Batch vs air-to-air processing

26. Hazards
Risk Assessment • Mechanical • Electrical • Thermal • Chemical • Material Interactions • Hazardous gases • Cold traps & Cryopumps • Cleaning hazards • Ergonomic & Miscellaneous.

27. Troubleshooting
Troubleshooting vacuum • Troubleshooting process • Troubleshooting winding problems • Troubleshooting adhesion • Troubleshooting - common problems & diagnostic tools • Thermal evaporation by resistance heated boats • Electron beam deposition • Magnetron sputtering

28 Final thoughts

Charles A. Bishop, Ph.D., C.Eng., MIMMM is an expert in vacuum deposition of thin film coatings and associated processes almost 30 years experience. He now runs his own consultancy business. Specializing in roll-to-roll processing of webs, films and foils, his expertise covers system design, process development and system control as well as troubleshooting. Other related expertise includes optical thin film modelling, radiation cure technology, and teaching/training of vacuum technology. Dr. Bishop is the author of over 50 technical papers and 5 patents. During his time in industry he worked for ICI as a senior research scientist in Surface Engineering within the New Science Group. His diverse ICI experience encompassed wide ranging applications including Nylons (fibre surface treatment by plasma), Polyesters, Explosives (vacuum deposited pyrotechnics), Imagedata (optical data storage) and Flex Products Inc (ITO, vacuum deposited pigments).

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Anyone working with the roll-to-roll deposition process will find this new book a unique and expansive journey of the process, with immediate benefits to manufacturing efficiency, unit cost reduction, and financial results.

VACUUM DEPOSITION ONTO WEBS, FILMS, AND FOILS (Charles A. Bishop, 2006)
http://yourlinkhere.com

This reference guide is a sweeping approach to the total design of the vacuum deposition process written by a successful and world renowned consultant with three decades of experience. It is a must-have guide for roll-to-roll machine operators, process engineers, and research and development engineers throughout industry. It will encourage a more comprehensive look from material supply through to the downstream processes that the product will encounter. It is a truly unique reference written to guide operators and engineers as an onsite consultant would.

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