YIELD IMPROVEMENT IN METALLIZING LINES BY USING CONTACT CLEANING TECHNOLOGY

1 INTRODUCTION

There has been a very large increase in the number and types of coatings applied in a vacuum environment. Various metals, ceramics and semiconductors are deposited which have very stringent functional requirements and as such are vulnerable to very small defects in the coatings caused by particulate contamination on the substrate. Contact cleaning technology can be successfully used to significantly increase yields in the production of functional films even within the vacuum chamber itself.

2 THE BACKGROUND OF CONTACT CLEANING

Contact cleaning is a very well established yield improvement technique used by many high technology manufacturing operations to increase competitiveness. The process was invented over twenty years ago, initially for membrane switch production though for many years the main applications were at various stages of the printed circuit board (PCB) manufacturing process. As different configurations and widths of machines were developed the technology was incorporated into lines processing web materials such as food and medical packaging, photographic films and functional coatings on polyesters and polycarbonates. In each of these applications users have benefited from significant increases in yields through the removal of loose contamination from the web. This technique can remove particles as small as 1 micron.

3 THE PRINCIPLE OF CONTACT CLEANING

The basic principles of contact cleaning involve a specially formulated elastomer roller rotating in contact with the web. See Figure 1. Due to its special formulation the elastomer roller picks up all loose dirt

and contamination from the web and transfers it to an adhesive roll ensuring that the surface of the elastomer which comes in contact with the web is always completely clean. The adhesive comprises a paper or film base coated with a pressure sensitive adhesive and wound on a core with the adhesive side facing outwards. It is essential that the properties of the pressure sensitive adhesive are tailored specifically for contact cleaning as it must be fully compatible with the elastomer and yet have sufficient adhesive and cohesive strength to ensure that there is no risk of transfer of any of the adhesive to the elastomer roller and subsequently to the product being cleaned. The elastomer must also contain no plasticizers or surfactants which might migrate onto the material being processed.

The system can be configured to clean one or both sides of the material and in some applications static control is added to the outlet of the equipment to minimise the risk of statically attracted particles recontaminating the web. See Figure 2. The equipment can be as small as 150mm (6”) wide and as large as 4000mm (13’) and can be specially designed to retrofit into an existing line.

4 ALTERNATIVE CLEANING TECHNOLOGIES

There are several other methodologies available for web cleaning but most of them relay on the use of air, either blowing or in vacuums to remove dust. While excellent for lifting large particles, the use of air has a major disadvantage when it comes to the removal of very small particles. The physical effect of the Boundary Layer acts as a barrier to the air flow trying to remove the small particles. The boundary layer is the stationary layer of air formed at the surface of a part. The thickness of the layer is related to the velocity of the airflow and to remove small particles down to one micron requires airspeeds which would adversely affect the web. A comparison of the different web cleaning techniques is shown in Figure 3 while Figure 4 gives a comparison of their efficiency curves. From these figures it can be seen the contact cleaning offers significant benefits in terms of removing smaller particles more efficiently and using considerably less power than the other cleaning methods used in web processing .

As the metallizing chamber itself is under vacuum it is often thought that particulate contamination is not an issue for this process however pinholing in the coating is often caused by very small particles which the vacuum does not remove. It is therefore necessary to ensure that the substrate placed in the vacuum chamber is free from dust and any other debris.

5 TYPES AND SOURCES OF CONTAMINATION

Full clean room production is still relatively rare in the metallizing industry so there are many opportunities for the material to pick up contamination from the environment.

- Clothing fibres, hairs and skin particles from operators are widespread in processing environments and are easily attracted to the materials through static electricity.

- The material will have been slit and rewound and fine slitting dust will permeate the roll.

- The cores on which the material is wound may become damaged and shed particles of plastic or resin.

- Cardboard or wooden packaging shed large amounts of cellulose fibres.

Even in clean rooms there are still very significant opportunities for contamination to be present on the material. To ensure that yields are not compromised by defects caused by this contamination it is necessary to thoroughly remove it. Figure 5 shows the effect small particles of dust have in a lamination process where tenting of the laminating film over the particle of debris engenders a defect seventeen times the diameter of the dust particle. Some manufacturers see an 80% reduction in defects after installing contact cleaning at appropriate stages in their production.

6 APPLICATION AREAS FOR CONTACT CLEANING

To minimise the risk of recontamination it is preferable to clean the material as close as possible to the vital process such as metallizing, coating or lamination. There are various stages where contact cleaning can be installed in the manufacture of metallized films.

- Where the process uses sheets of material which are individually metallized the sheets can be put through a double sided contact cleaner, with static control immediately before being loaded into the chamber.

- For web applications the reels of material are often cleaned offline in a separate, totally enclosed unwind/rewind unit with cleaning at the rewind station.

- Sometimes in web sputtering units there is a preprocessing chamber in which the material is unwound and contact cleaning can be installed onto one of the diverter rollers to clean the material coming off the reel or a cleaning station can be installed immediately before the pass through into the vacuum chamber.

- Recently some customers have been installing contact cleaning within the vacuum chamber itself to ensure the material is being cleaned immediately prior to the process. Obviously care must be taken to ensure that the contact cleaning system is fully compatible with vacuum operation and does not either degrade the performance of the vacuum or significantly increase the pump down time. It is absolutely essential to ensure that there is no free chemistry, plasticizers or other low molecular weight compounds within the elastomer used for the rollers which could adversely affect the adhesion of any coating being applied and which could also contaminate the vacuum pumps. Filmic based adhesive rolls are preferable to paper based ones to minimise the level of moisture within the chamber. The mechanics of the equipment itself must be designed and manufactured to vacuum standards especially with regard to oils and greases.

Figure 6 shows an installation of contact cleaning in an automotive windscreen metallization and lamination line.

7 CONCLUSION

Appropriate application of contact cleaning technology within the production of metallized products can significantly reduce defects caused by particulate contamination. This potential increase in yield is vital in products where the coatings have stringent functional requirements such as conductors in plastic electronics or sensor deposition. Flat screen production also benefits enormously from this technology.