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COMMUNICATION

THE ETIOLOGY OF PINHOLE AND BUBBLE DEFECTS IN ENTERIC AND CONTROLLED-RELEASE FILM COATINGS

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ABSTRACT

Film coatings are frequently applied to tablets or pellets in order to control or delay the release of medication from these dosage forms. Pinhole and bubble defects create weak points in the film through which fluid can penetrate relatively easily. It is postulated that bubble defects are continuously formed on the surfaces of tablets and pellets during the film coating operation because of foam produced by spray atomization of the coating solution. These bubbles are broken down rapidly during particle-to-particle collisions as the coating operation proceeds. Logos and very rough surfaces form protected areas free from abrasion which allow the bubbles to set or partially collapse to form pinholes.

INTRODUCTION

Film coatings may be applied to tablets or pellets in order to mask taste and color, protect the core from light or increase the ease of swallowing. Film coatings may also be used to control or delay the release of medication from the dosage form. Damage caused to the film as a result of improper processing (e.g. peeling and edging) or an inadequate formulation (e.g. cracking) compromises the integrity of the system.

Pinhole and bubble defects have also been seen in film coatings (1, 2). These create weak points in the film through which fluid can penetrate relatively easily. An understanding of the etiology of these defects is necessary in order to prevent their formation particularly in enteric and controlled-release film coatings. Microscopy has been used as a tool to investigate this problem.

METHODOLOGY

Various enteric film coated tablets and pellets under development were examined for pinhole and bubble defects in their coatings. Examination techniques included both optical (Wild M7A) and scanning electron (Jeol 820) microscopy. Micrographs from two dosage forms and one model system are presented as examples of typical observations. The illustrated systems include:

1. An enteric coated ASA tablet with depressed logo.
   Subcoat: HPMC from methanol/methylene chloride solvent
   Enteric coat: CAP/DEP from methanol/acetone solvent
   Spray nozzle: airless
2. Pellets (1 mm diam.) prepared by extrusion/spheronization.
   Subcoat: HPMC from water
   Enteric coat: Eudragit L30D/PEG 400
   Spray nozzle: air atomizing
3. Glass beads (3 mm diam., with surface imperfections), a model non-porous system.
   Subcoat: none
   Enteric coat: Eudragit L30D/PEG 400
   Spray nozzle: air atomizing

All coatings were applied using a bottom-spray Wurster technique.

RESULTS AND DISCUSSION

The logo area of tablets was found to be a primary location for pinhole and bubble defects. The logo of the model ASA tablet was found to contain mostly bubble defects in the enteric coating (Fig. 1 & 2). Transmission optical microscopy (Fig. 3) of the detached (laminated subcoat and enteric coat) film showed the bubbles in the enteric coat to coincide with pinholes in the subcoat (Fig. 4). It may be argued that both these defects occur as a result of gas escaping from the tablet core during the coating operations. Based upon the observations in Fig. 3, and considering the volatile nature of the coating solvents, this mechanism is highly probable. On the other hand, pinhole and bubble defects have also been observed when using aqueous-based film coatings.

FIGURE 1
Micrograph, prepared by transmission optical microscopy, of the enteric film removed from the model ASA tablet. (The subcoating has been partially washed away with water.) Note the bubble defects concentrated within the logo depressions.

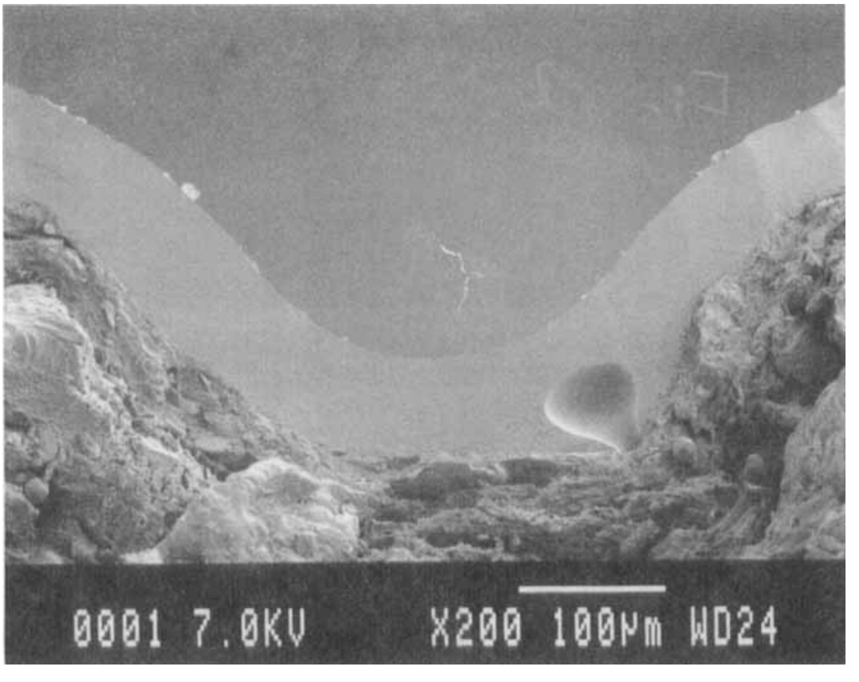

FIGURE 2
A cross-section view of the logo of the model ASA tablet showing a bubble defect in the enteric coating.

FIGURE 3
Micrograph, prepared by transmission optical microscopy, of the laminated subcoat the enteric coat detached from the model ASA tablet. Note how the bubble defects in the transparent enteric coating coincide with pinholes (bright spots) located in the subcoating.

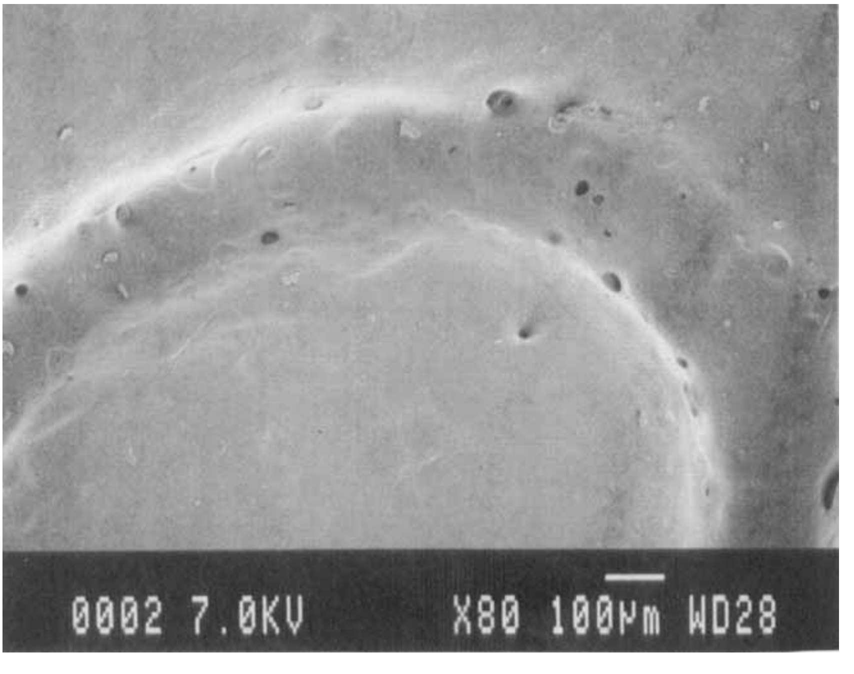

FIGURE 4
The logo of the model ASA tablet showing pinhole defects in the subcoating.

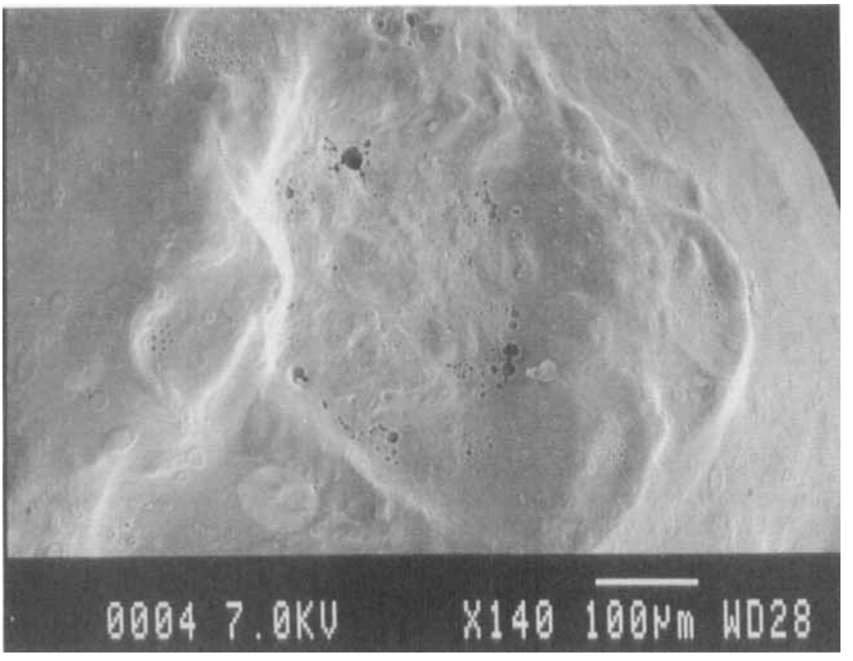

FIGURE 5
Pinhole defects in the enteric coating on a pellet, located in an area of high surface rugosity.

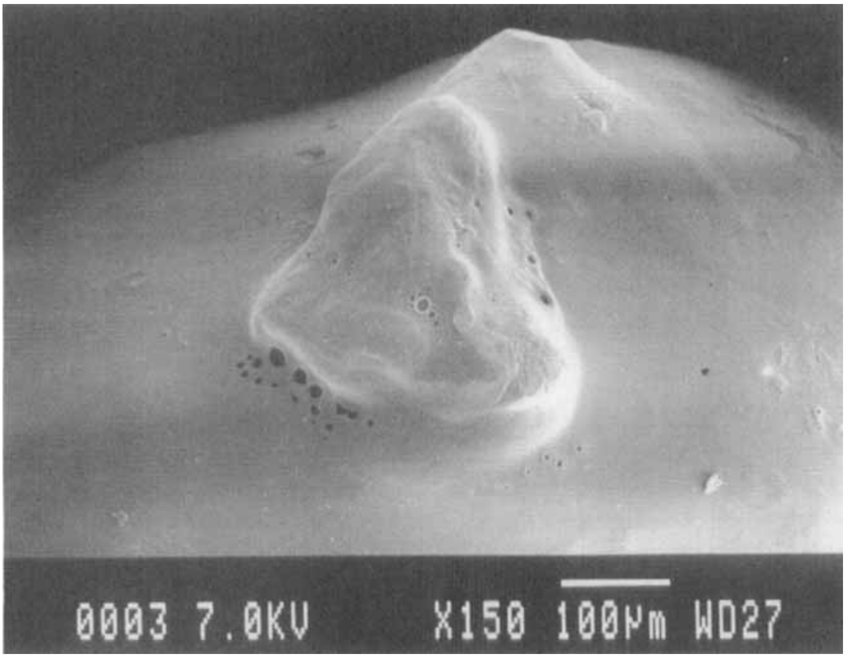

FIGURE 6
Pinhole defects in the enteric coating on a pellet, located around an adhering fragment of a broken pellet.

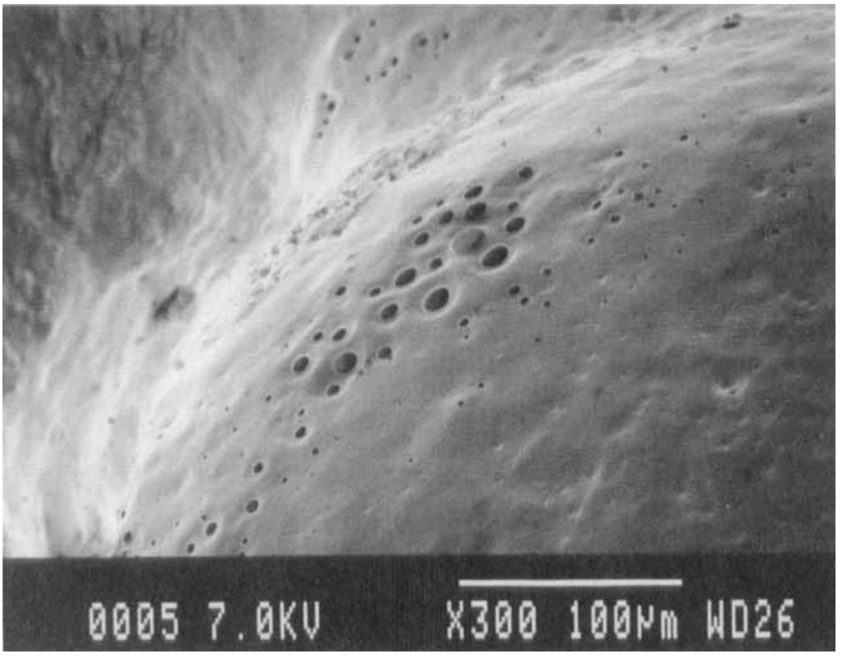

FIGURE 7
Pinhole defects located in a surface imperfection (depression) on a film coated glass bead.

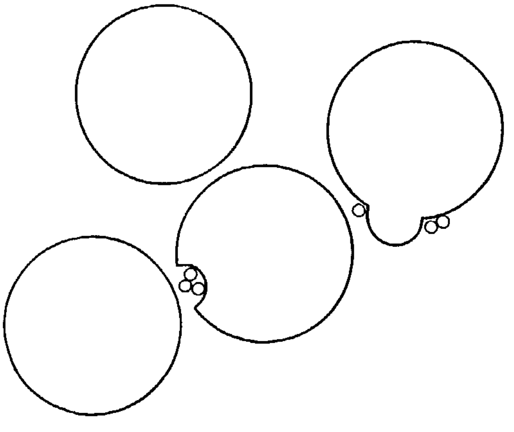

FIGURE 8

A diagramatic representation of the mechanism responsible for pinhole and bubble formation during film coating. Note how surface imperfections serve as protected areas, preventing bubble obliteration by particle-to-particle abrasion.

Film coatings applied to pellets have also been shown to be subject to the same defects. In this case pinholes and bubbles were found to be located primarily in areas of high surface rugosity (Fig. 5) and surrounding adhering fragments of broken pellets (Fig. 6).

In order to investigate the role of gas venting through the film as a source of defects, glass beads with surface flaws (depressions) were film coated using an aqueous-based system. Pinhole and bubble defects were seen predominantly in the surface depressions on the beads (Fig. 7). Because of the non-porous nature of the beads, this suggests that a mechanism of defect formation other than gas loss from the coating substrate is operative.

Based on a mechanism proposed (3) to explain logo obliteration during film coating of tablets, it is postulated that bubble defects are continuously formed on the surfaces of tablets and pellets during the coating operation because of foam produced by spray atomization of the coating solution. The bubbles are broken down rapidly during particle-to-particle collisions as the coating operation proceeds. Tablet logos and very rough surfaces on tablets and pellets form protected areas free from abrasion (Fig. 8) which allow the bubbles to set or partially collapse to form pinholes.

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