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COMMUNICATION

The Influence of Tablet Shape and Pan Speed on Intra-tablet Film Coating Uniformity

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ABSTRACT

Four different tablet shapes (round, oval, capsule, and large oval) were coated in a small-scale coating pan at three different pan rotational speeds. The coating film thickness was measured on the top face, the edge of the land, and the belly band of each tablet shape. The results showed that tablet shape directly influences intra-tablet coating uniformity (uniformity decreasing from round, oval, capsule, to large oval). In almost all cases, coating uniformity increased with pan speed.

INTRODUCTION

Coating uniformity is crucial to the biological performance of film-coated modified release dosage forms. Understanding the factors affecting coating uniformity can improve performance reliability, reduce processing time, and resolve manufacturing issues. Work has been done to understand and improve the inter-tablet coating uniformity by controlling the tablet movement in the pan and the coating parameters (1,2,3). Others have examined the effect tablet shape plays in the modified drug release characteristics from matrix tablets (4,5,6,7) and modified release coatings (8).

Coating thickness is known to influence the diffusion rate through the sustained-release coating. The drug release rate through a sustained-release coating is dependent on both the tablet surface area and the coating thickness uniformity. Coating thickness is also important in attaining an enteric coating. It is therefore important, when modified release coating is used, to carefully select the tablet shape and process parameters capable of influencing intra-tablet coating uniformity.

The objective of this work was to develop an understanding of the critical factors such as tablet shape and pan speed that influence intra-tablet coating uniformity. Spherical tablets will obviously have the best uniformity because there is no preferred spatial orientation, and will have all parts of the surface equally exposed to the spray coating over time. This is the case when coating beads. As the tablet shape diverges from spherical to a flatter

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shape, it is more likely to have a preferred spatial orientation in the tablet bed. The flatter and broader the tablet, the more likely it is to pass through the spray zone flat with the face exposed. The rotational exposure of all tablet faces required for uniform coating can be enhanced by increasing the motion of the tablet bed (e.g. by increasing the pan speed). Higher pan speeds can cause the flatter tablets to sometimes pass through the spray zone on end, coating the edges and ends of the tablets. This paper seeks to confirm these proposed concepts of tablet shape and pan speed using four typical tablet shapes composed at three different pan speeds.

MATERIALS AND METHODS

Tablets of different shapes and sizes (Table 1) were coated in a 11.5-in. Freund Mini-Hi-Coater (Vector Corp., Marion, IA) with mixing baffles, using 800-g batches. An organic Eudragit (Rohm Tech, Malden, MA) 13% solids solution (containing plasticizer, pigment, and talc) was used to coat the tablets. The coating outlet air temperature was held at 25°C with an inlet air temperature of 32°C, and the spray rate was held at 8 g/min using a peristaltic pump (Cole Parmer, Niles, IL). The coating time was calculated to apply 30 mg of coating per tablet. Since the amount of tablets per coating batch varied with tablet weight, coating times varied from 45 to 60 min. Tablet surface differences (due to formulation) were not investigated since the tablets quickly received a layer of coating that made the tablet surfaces identical for the majority of the coating process.

Pan speed was investigated by coating the same batch of one tablet shape three times at three different pan speeds (9, 14, and 21 rpm), alternating the coating color at each pan speed. The first and third coating contained red pigment and the second coating did not contain pigment. Coating thickness for different pan speeds were easily measured due to the color transition.

Five tablets of each shape were prepared for microscopy by fracturing cross-sectionally along the major axis using a Teflon-coated razor blade. A Nikon SMZ-U microscope with a Hitachi HV-C11 CCD camera was used to take photos of the different coating thicknesses. Every tablet was measured four times at each location (Fig. 1). Average measurements were based on 20 measurements per location at every pan speed. To account for the tablet surface area differences between the

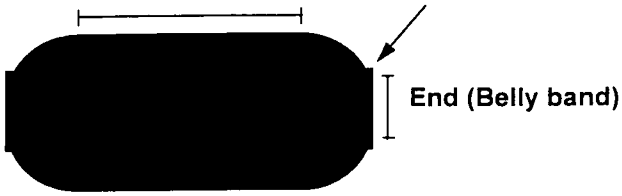
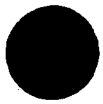


Figure 1. Positions where the coating thickness measurements were made.

Table 1

Tablet Dimensions and Shape

Tablet Shape	Dimensions	(mm)	Top View (l x w)	End View (w x h)
Round	Diameter Height	11.3 5.2		
Capsule	Width Height Length	6.0 6.0 14.9		
Small Oval	Width Height Length	7.8 5.4 14.7		
Large Oval	Width Height Length	7.1 5.9 17.7		

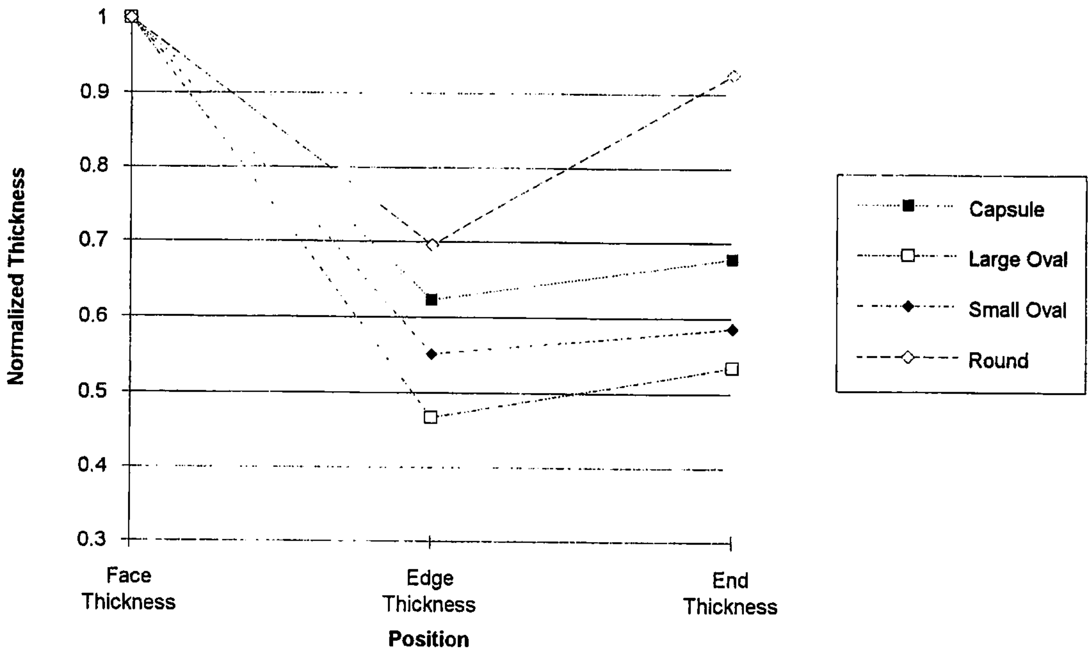


Figure 2. Coating thickness with respect to position.

different shapes, all thickness measurements were normalized by dividing by the average face coating thickness for that tablet shape. Therefore, the average face coating thickness is 1.00 for all shapes.

RESULTS AND DISCUSSION

Intra-tablet coating uniformity for the different shapes is shown in Fig. 2. The error of the averaged measure-

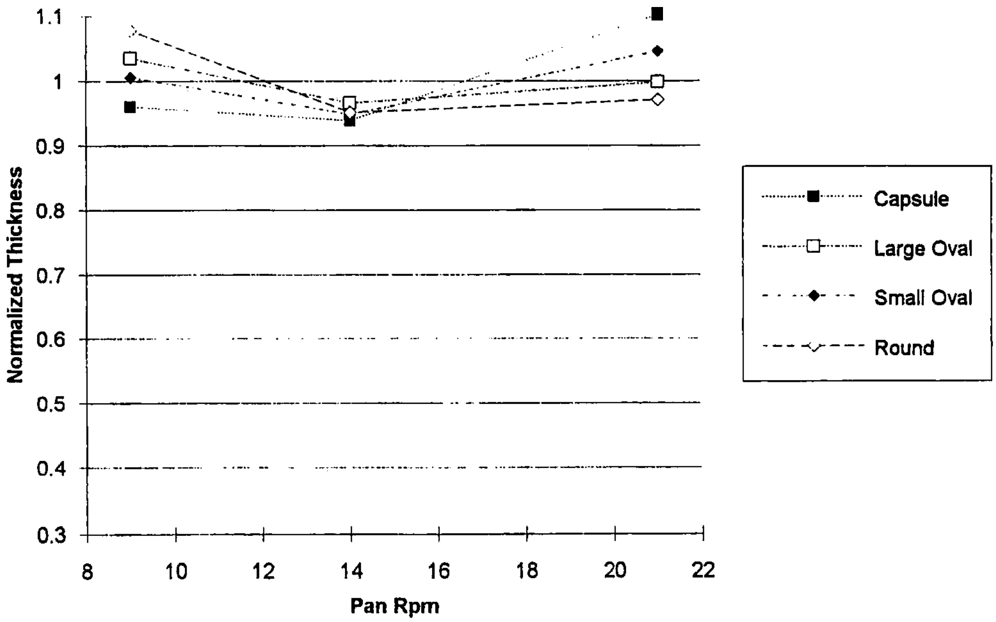


Figure 3. Face coating thickness as a function of pan rpm.

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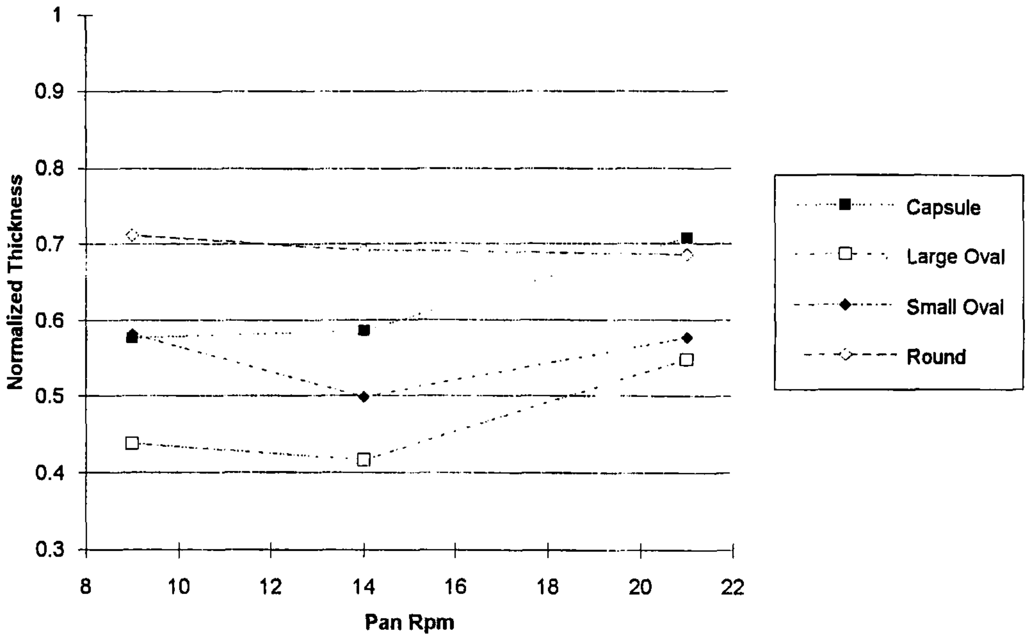

Figure 4. Edge coating thickness as a function of pan rpm.

ments was less than 0.03. Predictably, the round tablet, which is the most spherical tablet, had the greatest coating uniformity. The closer the shape is to spherical, the more random will be the tablet's orientation in the spray zone. The worst shape for coating uniformity is the large oval that is not mobile enough to move out of its flat orientation as it passes through the spray zone. The edge and end coating thickness for the large oval were

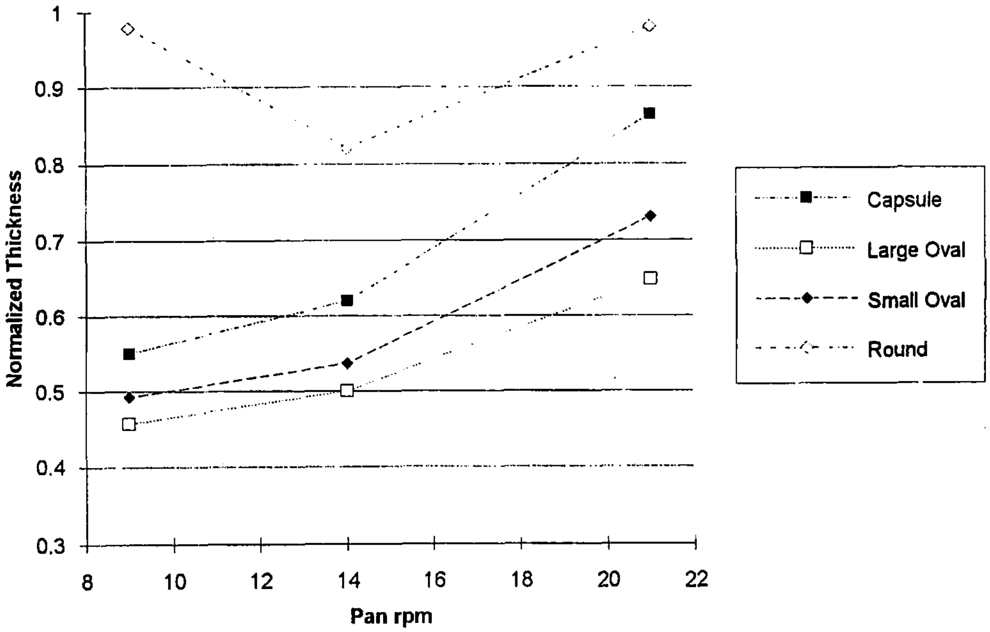

Figure 5. End coating thickness as a function of pan rpm.

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approximately 50% of the face thickness. The improvement of caplet over the oval shapes may be due to the ability of the narrow caplet ends to fit in the spaces between caplets and rotate more freely albeit its non-spherical shape.

By graphing the effect of pan speed on the coating thickness of the different locations, it is seen that face thickness and edge thickness do not change appreciably (Figs. 3 and 4). End thickness is highly dependent on pan speed (Fig. 5) for all shapes except the round that already has good coating uniformity at the low speed. As the speed increases the oblong tablets apparently tumble through the spray zone rather than sliding flat, so the end exposure is more frequent and the coating becomes more uniform.

The dip in the end thickness of the round tablet at 14 rpm may be the result of overwetting occurring at 9 rpm. Since the spray rate was kept constant, at 9 rpm the coating addition per pass is the highest. The round tablets may have been tacky at the slow pan speeds, thus causing the tablets to tumble better than at 14 rpm, at which tackiness did not play a role.

CONCLUSIONS

Tablet shape can significantly influence intra-tablet coating uniformity. In all cases the coating was thicker on the face than on the edges or ends of tablets. The most dramatic difference was shown by the large oval followed by the small oval, caplet, and the round tablet, which showed the lowest relative thickness variation. The more spherical the geometry, the more uniform the coating is likely to be. Increasing the pan rotational speed improved the intra-tablet coating uniformity in almost all cases. The round tablets were the most spherical but showed an increased uniformity at low and high pan speed which has been attributed to increased tackiness.

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