

Tablet Coating in the Novel SUPERCELL™ Coater: Evaluation of Color Uniformity

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Figure 1:
The SUPERCELL™ Coater
Niro Pharma Systems, USA

Introduction

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SUPERCELL™ Coating Technology (SCT) was developed with the ability to uniformly and rapidly coat small batches of objects having a major diameter between 3 to 35 mm with a high degree of accuracy. The SCT coating apparatus shown in Figures 1 and 2 is described in US patent 6,209,479 and EP patent EP 1,140,366 and eqv. [1-2]. The coater consists of a conical processing chamber that sits on top of a gas distribution plate (roto-nozzle). The roto-nozzle contains gas jets designed to accelerate the objects for coating, e.g. tablets, through the coating zone in a ballistic flight path. The gas jets impart momentum to the tablets such that they are rotating as they pass through the coating zone (Figure 3). Coating material is atomized by means of a specially designed low-momentum two-fluid spray nozzle located below the gas distribution plate (Figure 4). Normally, the momentum from a two-fluid nozzle can accelerate objects such as tablets fast enough that they are easily damaged when they strike a surface or fall. In SCT, the atomizing gas is mixed with low-pressure drying gas in order to dissipate the momentum generated in the atomizing process. Tablets are coated co-currently with the drying gas. At the end of the coating process, the tablets are pneumatically conveyed out of the processing chamber.

Relative standard deviations (RSD) below 2% have been achieved for total coating contents as low as 200 mg per object. The coating accuracy of SCT has also been investigated on conventional pharmaceutical tablets [3]. In that study, SCT was used to apply low doses of an active drug onto tablets. Inter-tablet coating uniformity was evaluated using the RSD of the active drug content (determined by HPLC analysis) of the coated tablets. This study demonstrated that drug content RSDs of less than 5% could be achieved for doses as small as 200 micrograms using SCT. However, this method could only be used to evaluate inter-tablet coating uniformity. It does not provide information on the intra-tablet distribution of the active drug in the tablet coat.

Tristimulus colorimetry is a spot color measurement method that can give information on both the uniformity of coating between tablets and on individual tablets. Compared to active drug content HPLC analysis [3], it has also the advantage of being a non-destructive method. Colored pharmaceutical coatings are used in the coating of solid dosage forms for aesthetic as well as for identification purposes. Color uniformity can be used as a response for evaluating a coating process [4]. Variability in the color on the surface of a dosage form, and between dosage forms should ideally be low as differences in color often point to poor or inadequate process control during production, or to poor product quality.



Figure 3: The SUPERCELL™ coating process

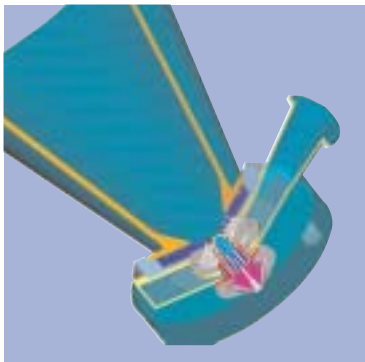


Figure 2: The SUPERCELL™ coater assembly

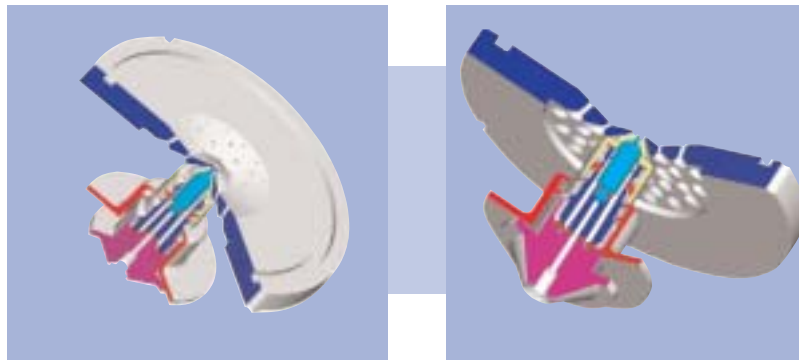


Figure 4: Cutaway views of roto-nozzle and liquid nozzle

Objectives

To evaluate inter-tablet and intra-tablet color uniformity of tablets coated by SUPERCELL™ Coating Technology.

Materials and Methods

MATERIALS

Placebo tablet dimensions:

Mean weight - 91 mg

Mean diameter - 6 mm

Coating suspension formulation:

Opadry yellow [03B25809] (Colorcon, USA) coating, prepared in a 12% solids aqueous suspension.

METHODS

SUPERCELL™ Coating

Three different batch sizes (30, 60 and 90 g) of tablets were evaluated with SCT. For each tablet batch size, batches of different theoretical coating levels (0.6-3.8% weight gain) were color-coated using the SUPERCELL™ coater. The coating process conditions used are given in Table 1.

Code	Tablet batch size (g)	Air flow rate (m ³ /h)	Inlet air temp (C)	Plenum pressure (cm WC)	Atomizing air pressure (bar)	Volume applied (mL)	Spray rate (mL/min)	Coating level (%)	Batch Time (s)
30g-0.6%	30.3	12.83	120	800	2.5	1.46	4	0.6	22.9
30g-1.3%	30.3	12.83	120	800	2.5	2.93	4	1.3	45.0
30g-1.9%	30.3	12.83	120	800	2.5	4.39	4	1.9	66.9
30g-2.5%	30.3	12.83	120	800	2.5	5.85	4	2.5	88.8
30g-3.2%	30.3	12.83	120	800	2.5	7.32	4	3.2	110.8
30g-3.8%	30.3	12.83	120	800	2.5	8.78	4	3.8	132.7
60g-0.6%	60.6	17.56	120	1500	2.5	2.93	6	0.6	30.3
60g-1.3%	60.6	17.56	120	1500	2.5	5.85	6	1.3	59.5
60g-1.9%	60.6	17.56	120	1500	2.5	8.78	6	1.9	88.8
60g-2.5%	60.6	17.56	120	1500	2.5	11.71	6	2.5	118.1
60g-3.2%	60.6	17.56	120	1500	2.5	14.64	6	3.2	147.4
60g-3.8%	60.6	17.56	120	1500	2.5	17.56	6	3.8	176.6
90g-0.6%	90.9	19.48	120	1800	2.5	4.39	9	0.6	30.3
90g-1.3%	90.9	19.48	120	1800	2.5	8.78	9	1.3	59.5
90g-1.9%	90.9	19.48	120	1800	2.5	13.17	9	1.9	88.8
90g-2.5%	90.9	19.48	120	1800	2.5	17.56	9	2.5	118.1
90g-3.2%	90.9	19.48	120	1800	2.5	21.95	9	3.2	147.4
90g-3.8%	90.9	19.48	120	1800	2.5	26.35	9	3.8	176.6

Table 1: Coating Process Conditions

Color Measurements by Tristimulus Colorimetry

Color measurements were made using a tristimulus colorimeter (Chroma Meter CR-241, Minolta, Japan). Average daylight with ultraviolet wavelength, standard illuminant D65, was used as the light source. Color measurements were taken in $L^*a^*b^*$ color space, also referred to as CIELAB space. L^* indicates lightness; a^* and b^* indicate color directions where $+a^*$ is the red direction, $-a^*$ is the green direction, $+b^*$ is the yellow direction and $-b^*$ is the blue direction.

Thirty tablets were randomly sampled from each coated batch for color measurements in the tristimulus colorimeter. Three color readings were taken over a 1.8 mm diameter spot and the values averaged for each tablet surface. For each tablet, color measurements were made on both faces of the tablet. The mean $L^*a^*b^*$ values of the core (not color-coated) tablets was used as the initial color of the tablets ($L^*_o = 96.59$; $a^*_o = -0.12$; $b^*_o = 3.88$).

The degree of color difference, dE_i , for the color measurement made on each color-coated tablet surface (L^*_i, a^*_i, b^*_i) was calculated based on the initial color on the raw tablets using the following equation:

$$dE_i = [(L^*_o - L^*_i)^2 + (a^*_o - a^*_i)^2 + (b^*_o - b^*_i)^2]^{1/2}$$

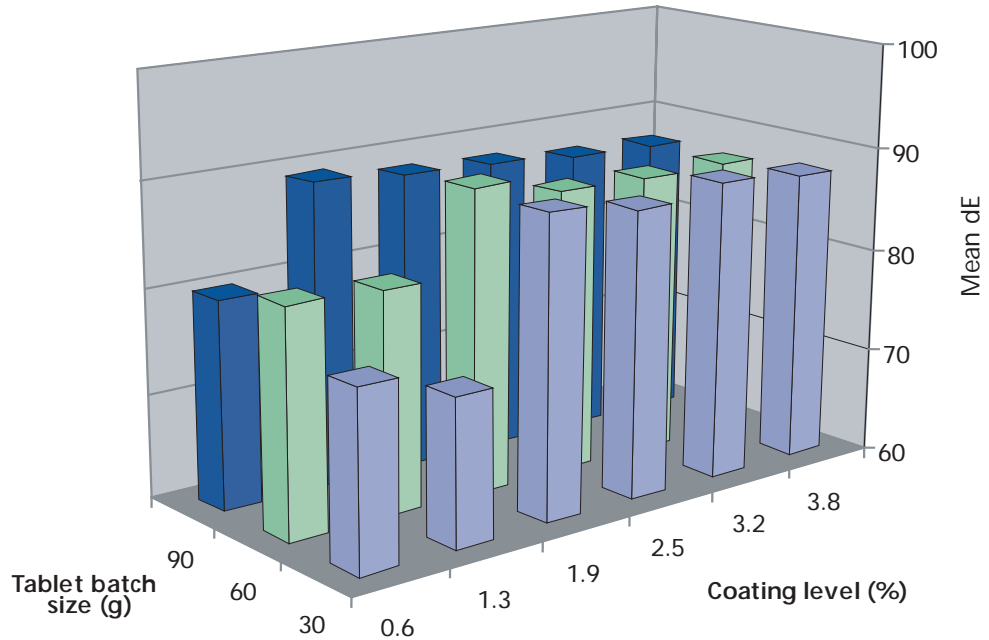
dE_i gave a quantitative measure of the degree of yellow coloration deposited onto the surface of a color-coated tablet; a higher dE_i value would indicate a higher degree of yellow coloration. The mean dE for each color-coated batch was derived from a total of 60 color measurements carried out on both faces of the 30 randomly selected tablets. The relative standard deviation (RSD) of the mean dE for a color-coated batch gave an indication of its inter-tablet color variation.

The difference in the dE_i values taken from the two faces of a color-coated tablet, $dE_{ia} - dE_{ib}$, also provided comparative information on the distribution of the yellow coloration on an individual tablet. Mean $dE_{ia} - dE_{ib}$ of a color-coated batch was the averaged color difference between two tablet faces as obtained from 30 randomly selected tablets.

Results

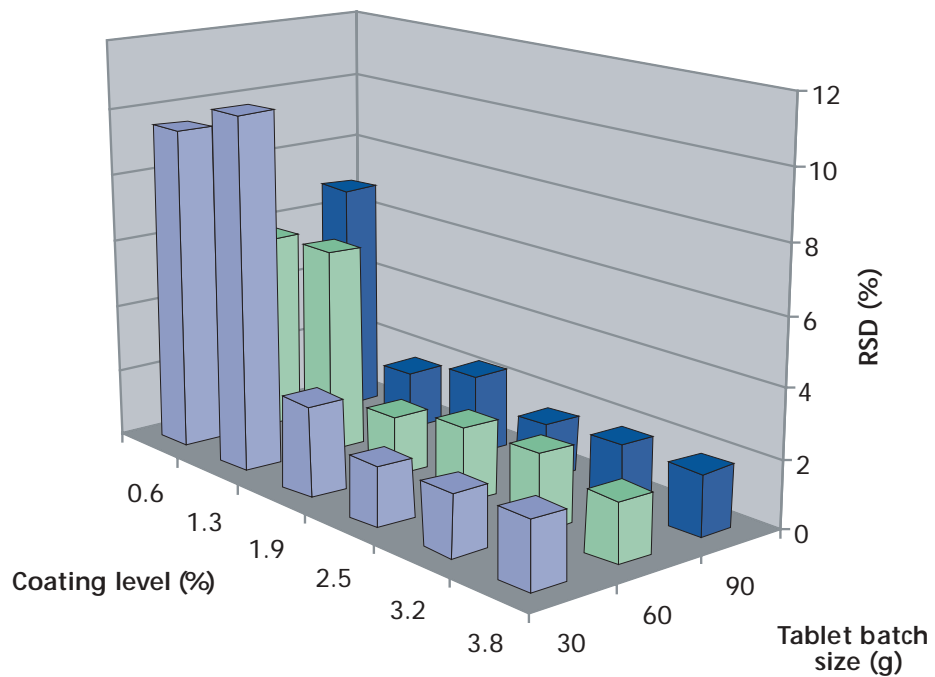
For the three different tablet batch sizes, mean dE increased with an increase in the deposition of yellow coloration onto the tablet surfaces when the coating level was increased from 0.6% to 1.9% (Figure 5). In general, the 30 g batches had lower mean dE values at coating levels of 0.6-1.3%. Hence, these tablet batches had comparatively lower degrees of yellow coloration than the 60 g and 90 g batches at the corresponding coating levels. For both the 30 g and 60 g tablet batch sizes, a plateau in mean dE was reached after which further coating beyond 1.9% coating level did not produce any significant change in color as detected by tristimulus colorimetry. For the 90 g tablet batch size, the plateau in mean dE was reached at a lower coating level of 1.3%. These results showed that a higher degree of yellow coloration can be deposited with a lower coating level when the tablet batch size was increased from 30 g to 90 g.

Figure 5: The influence of tablet batch size and coating level on mean dE of SCT color-coated batches



From Figure 6, the RSD values of the mean dE for the color-coated batches decreased appreciably (from 6-9.5% down to <3%) with an increase in coating levels from 0.6% to 1.9%. The RSD values leveled off after 1.9% weight gain for the 30 g and 60 g batches, and after 1.3% for the 90 g batches. In general, the inter-tablet color variation of color-coated tablet batches could be minimized to about 2% with coating levels of 1.9% and beyond. It was also observed that at low coating levels of 0.6% and 1.3%, the RSD values for the 30 g batches (RSD: 9.5% & 10.5%) were markedly higher than the corresponding RSD values for the 60 g and 90 g batches (RSD: 5.8% & 6.0%; 6.9% & 1.7%).

Figure 6: The influence of tablet batch size and coating level on color uniformity of SCT color-coated batches.



These findings indicated that at low coating levels, a more homogeneous color coat can be achieved with the larger tablet batch sizes evaluated in this study. The increase in tablet batch size from 30 g to 90 g increased the number of tablets and the total surface area available in the coating zone for coat deposition. As a result, this led to less spray drying and an improvement in the overall efficiency of the spray coating process.

For the 30 g and 60 g tablet batches, mean $dE_{ia} - dE_{ib}$ values were higher at low coating levels of 0.6-1.3% (Figure 7). Mean $dE_{ia} - dE_{ib}$ decreased with further coating beyond 1.9% coating level indicating that differences between the yellow coloration on the 2 faces of a tablet tended to level off after 1.9% coating level. For the 90 g batches, the leveling off of mean $dE_{ia} - dE_{ib}$ was observed at a lower coating level of 1.3%.

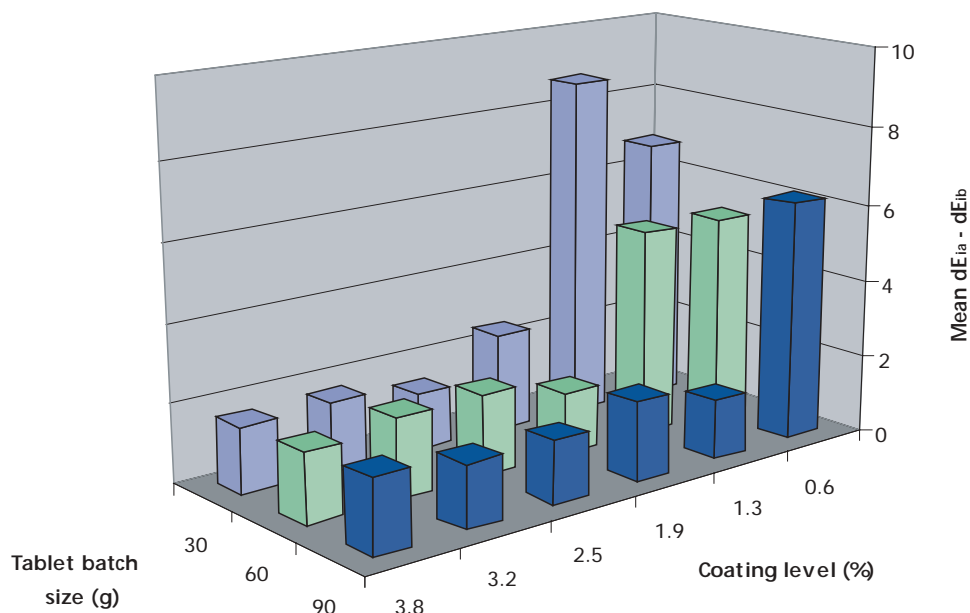


Figure 7: The influence of tablet batch size and coating level on mean color difference between two tablet faces in the SCT color-coated tablet batches.

Conclusions

Color measurements demonstrated the influence of batch size on tablet coating uniformity in the SUPERCELL™ coating process. With the SUPERCELL™ coater, inter-tablet color uniformity can be achieved at coating levels of just 1.9% for the tablet batch sizes investigated. This was most evident in the 90 g batch size, where a low RSD of 2% was obtained at a coating level of 1.3%. Similarly, intra-tablet color variation determined by comparing color difference between the 2 faces of a tablet tapered off to a minimum beyond 1.9% coating level for the 30 g and 60 g batch sizes and beyond 1.3% for the 90 g batch sizes.

References

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4. L.W. Chan, W.Y. Chan and P.W.S. Heng. An Improved Method for the Measurement of Colour Uniformity in Pellet Coating. Int. J. Pharm., 213, 63-74 (2001).



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