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COMMUNICATIONS

The expansion and contraction of tablets during film coating—a possible contributory factor in the creation of stresses within the film?

R. C. ROWE, *ICI Pharmaceuticals Division, Alderley Park, Macclesfield, Cheshire SK10 2TG, U.K.*

The concept of stresses being developed in a film coating caused by it shrinking over a tablet substrate on evaporation of the solvent was first proposed by Rowe (1978) to explain apparently anomalous film/tablet adhesion results. The concept has recently been expanded to explain the causes of such film defects as film cracking, edge splitting and peeling and bridging of the intagliations or monograms (Porter 1980; Rowe & Forse 1980a, 1980b). The question arises as to why the stresses are higher in films on some substrates than on others, making them more susceptible to such film defects when coated under the same conditions and with the same film formulation.

A possible contributory factor could well be the differences in the degree of expansion and contraction of both the film and tablet substrate during the heating and cooling phases of the coating process—a concept already well accepted in both the adhesives (Meissner & Baldauf 1951; Gardon 1967) and paint technologies (Hamburg & Morgans 1979). If for example, during a cooling phase, e.g. at the end of a coating run, the film and tablet contract to the same extent less stress will be developed than if the film contracted a great deal more than the tablet. Although these dimensional changes will be a function of the complete formulation and hence are difficult to estimate, it is possible to compare materials using documented data on their coefficients of thermal expansion (Table 1).

Table 1. Coefficients of expansion of some representative materials used in tablet compression and film coating (temperature ambient unless otherwise stated).

Material	Coefficients of thermal expansion × 10^{-4} Linear	Cubic	Reference
Glucose	—	2·8	Parks et al (1928)
Sucrose	—	2·3 (<67 °C) 5·0 (>67 °C)	Liley & Gambill (1974)
Sodium chloride	0·4	1·2	Ibid
Stearic acid	—	8·1 (<45 °C)	Ibid
Calcium carbonate	0·1–0·3*	—	Clarke (1928)
Magnesium carbonate	0·06–0·2*	—	Ibid
Ethyl cellulose	1·0–1·4	3·0–4·2	Hercules Inc (Manufacturers literature)
Cellulose acetate	0·8–1·6	2·4–4·8	Ibid
Shellac	—	2·7 (<46 °C) 13·1 (>46°C)	Liley & Gambill (1974)

* These materials are anisotropic and hence have different coefficients of expansion along different axes. The values given are the lowest and the highest.

The low value for magnesium carbonate compared with the values for the cellulose derivatives and the similarity in values for the sugars and the cellulose derivatives are interesting firstly because the tablet core formulation used by Rowe & Forse (1980a), which was so prone to edge splitting and peeling, contained a high proportion of magnesium carbonate, and secondly, because many tablet formulations are based on sugars, and such formulations are not generally held to create many problems on coating.

Of course, data on the dimensional changes of complete formulations are necessary before definite conclusions can be drawn, but the evidence presented does suggest that differences in the thermal expansion and contraction of both the tablet core and film coating could well be a factor in the creation of stresses within film coatings and the cause of the higher incidence of film defects with some tablet formulations.

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