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RESEARCH ARTICLE

Analysis of Pharmaceutical Tablet Coating Uniformity by Laser-Induced Breakdown Spectroscopy (LIBS)

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Abstract A laser-induced breakdown spectroscopy-based analytical methodology is developed to study tablet coating variability in pharmaceutical tablets. The method quantifies the amount of coating on a tablet by assigning an average coating thickness score to it. When tested using samples with different amounts of coating, the coating thickness scores showed direct correlation to the weight gain of the tablet, hence validating the analytical method. The relative significance of the processing parameters and the components of variability were computed using statistical techniques. The sampling frequency of laser shots was found to have no significant effect. The effect of the position of the laser pulse on the tablet surface was found to be significant; however, it was determined that this effect was due to the tablet curvature, which resulted in the laser optical path to intersect the coating diagonally. The variability between batches (lots) manufactured under the same processing conditions was not significant. The largest avoidable source of variability was the tablet-to-tablet component, possibly indicating the inadequate mixing performance of the coating device.

Keywords Tablet coating · Laser-induced breakdown spectroscopy · Content uniformity · Pharmaceutical process engineering

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Introduction

Tablets are the most commonly used medical dosage delivery forms. Almost all pharmaceutical tablets are coated, for a variety of reasons, such as to mask the unpleasant taste of the ingredients, enhance the appearance of the product, modify drug bioavailability, and to add drug molecules to the tablet. Thus, excessive coating thickness variability can cause a variety of problems, ranging from poor appearance to variability in drug content and dissolution rates.

A popular method of imparting coating is by the use of perforated coating pans, which are rotating devices wherein the tablets tumble as they are sprayed with coating material and exposed to hot air, which is used to dry the coating. It is well known that these devices suffer from slow axial mixing, which can cause variability in coating thickness [1, 2]. In addition, coating variability, or, more generally, coating defects, can occur for multiple reasons, including tablets sticking to each other and to pan surfaces, too fast or too slow spraying, etc.

Several methods have been used to characterize coating variability, whether within tablets or between tablets. The usage of near-infrared (NIR) spectroscopy as a process analytical technique to study and improve the tabletting process has been reported [3] and also used in-line [4]. Terahertz pulse imaging has been shown to provide comparable results to NIR in the monitoring of the coating process and the growth of the coating layer [5, 6]. Confocal laser scanning microscopy has been used to image the film–core interface and surface defects in coated tablets and, in conjunction with a laser profilometer and optical roughness analyzer, has provided a useful guideline to the relationship of spraying air pressure and coating roughness [7]. The popular Raman spectroscopy technique has also been