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Ph.D. Seminar Talk 1

Title: **Experimental Investigation of Polymeric Spray Impingement and Wall Filming for Transdermal Drug Delivery**

Speaker: **Mr. Amit Yadav (ME21D408)**

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Date and Time: **27-02-2026 @ 2:30 PM**

Venue: <https://meet.google.com/wnm-jugf-jyt>

Abstract

Transdermal drug delivery (TDD) offers a non-invasive route for achieving local or systemic therapeutic effects. Film-forming spray systems using ethanol as solvent and Eudragit E100 as a film-forming polymer are widely employed in such applications. This research investigates the influence of polymer concentration on spray characteristics and liquid film formation over a synthetic skin model (Strat-M membrane). Polymeric solutions were atomized using a commercially available spray pump. The spray was characterized using Phase Doppler Particle Analyzer (PDPA) technique. Time-resolved images of the liquid film were acquired using planar laser-induced fluorescence (PLIF) to accurately track the interface, thereby providing a measurement of the spatio-temporal evolution of the film height. Results show that increasing polymer concentration reduces spray cone angle and generates larger droplets with lower velocity. This modifies the spreading and evaporation behaviour when the spray impinges on the substrate. Time evolution of the mean and standard deviation of film height revealed four film evolution regimes: impact regime, inertial spreading, viscous adjustment, and evaporation-driven thinning. The influence of polymer concentration on film height facilitated an improved understanding of the competing roles of viscosity and evaporation rate in governing film dynamics.

To address the limitations of conventional spray pumps (mean droplet size $\sim 100 \mu\text{m}$) and to promote faster drug diffusion, a piezoelectrically actuated vibrating mesh atomizer was utilized. The atomiser produces substantially finer droplets ($\sim 10 \mu\text{m}$ or less), thereby facilitating uniform and controlled thin-film deposition. A mathematical model predicting optimal droplet size indicated that droplets $\geq 8 \mu\text{m}$ effectively impinge on the substrate, while smaller droplets follow airflow streamlines. Based on this analysis, a suitable mesh for the vibrating mesh atomizer was selected to achieve high deposition efficiency. Drug diffusion experiments were conducted using a flow Franz cell, with clotrimazole as a drug and Eudragit E100 as the film-forming polymer. The performance of the vibrating mesh atomizer was compared with that of the spray pump. The results showed that the vibrating mesh atomizer achieved a significantly higher drug diffusion rate (over a 12 hr experimental duration) compared to the spray pump.