A Study of the Drug Deposition Mechanisms on Pre-treated hardware of Metered Dose Inhalers

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If we knew what we were doing, it would not be called research, would it?

Albert Einstein
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1. Introduction: Inhalers

- pMDIs are the most commonly used devices today for inhalation treatment.

Dose uniformity of pMDIs is a key parameter for effective inhalation therapy.
1. Introduction: Drug Deposition Phenomena

- Drug deposition can occur on all pMDI hardware exposed to the formulation leading to dosage variation.
1. Introduction: Drug Deposition Phenomena

The published studies on drug deposition in pMDI devices relate to:

- Particle-particle interaction;
- Design of the hardware;
- Moisture and temperature storage conditions.

However, there are limited studies concerning the effect of surface treatments applied to the hardware of the inhaler.
2. Aim of this Project

➢ To relate surface treatments applied to the pMDI canister to drug deposition phenomena and surface chemistry and topography.
3. Experimental Approach/Techniques

Explore drug deposition mechanisms on canisters

Surface treatments applied

Physicochemical characterisation

Drug deposition test

3M fluorosilane coating
Parylene coating
Anodisation pre-treatment
FEP coating
PES coating

Scanning Electron Microscopy (SEM)
Atomic Force Microscopy (AFM)
X-ray Photoelectron Spectroscopy (XPS)
Contact Angle (CA)
4. Results: Surface Topography-SEM Analysis

PES coating+3M fluorosilane

EHT = 5.00 kV
Mag = 30.00 K X
VD = 2.4 mm

EHT = 5.00 kV
Mag = 1.00 K X
WD = 23.4 mm
4. Results: Surface Roughness-AFM Analysis

Untreated Can

Parylene coating
Anodisation treatment
3M fluorosilane
PES+3M fluorosilane
4. Results: Surface Chemistry-XPS Analysis

Different Surface Treatments

- Untreated can
- FEP
- Parylene
- Anodised
- Anodised+3M fluorosilane
- 3M fluorosilane
- PES+3M fluorosilane

Aluminium %, Fluorine %, Carbon %
4. Results: Surface Free Energy and Drug Deposition

- untreated can
- FEP
- Parylene
- Anodised
- Anodised+3M fluorosilane
- 3M fluorosilane
- PES+3M fluorosilane

- $\gamma_{\text{tot}}$ (mN/m)
- DD %
4. Results: Drug Deposition vs Relative Humidity (RH)

- **Drug Deposition %**
- **Relative Humidity (RH) %**

- **FEP**
- **Untreated can**
- **3M fluorosilane**
- **PES+3M fluorosilane**

Graph showing drug deposition percentage against relative humidity for different materials.
Drug deposition on pMDI canisters varied considerably across a range of samples with different coatings applied.

Deposition was found to correlate very strongly with total surface free energy and surface roughness.

Coatings depositing high surface fluorine and providing both low surface free energy and low surface roughness gave the best performance.

The PES+3M fluorosilane combination coating treatment, resulted in the lowest drug deposition values which were maintained across a wide range of test humidities.
6. Future Work

- Explore application of coatings to valve and actuator components.

- Investigation of work of adhesion between target inhalation APIs and 3M fluorosilane coated surfaces.
Thank you for your attention

Questions?
References

[1] Image of Einstein: https://www.google.de/search?q=albert+einstein+images&tbm=isch&tbs=rimg:CaGP3vLvUn6Dljj-TyKVO2LFXrjkcqcnWHce6vEvStV7L7XwWuncRh_1rQk-SxmVWM8gRypG9rBnnxhAEWcGRsGCoSCf5PlpU7YsVeEXy6w._1pR3bbBKhhJuWuNypydYdwRF3vFGOh-6isqEg17q8S9K1UtBFW-Lu5aVf5OioSCZexa6dxGH-TEST2W-jTHB-ehkiLJCST5LGVYzyARZD15OUK61buQgEglGlikb0sGeeRHziGbax2a5CoSCiGEARZwZGwYEXVruw2Jy4t_1&bo=u&sa=X&ved=0ahUKEwiGq-bNnjXAhWM7RQKHWirDOEQ9C8IHw&biw=1341&bih=589&dpr=1#imgrc=oY_e8u-dToPfYM:


