Design and development of a novel diffusion cell for advanced UV imaging to characterise pharmaceutical formulations

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Introduction

Permeation tests are conducted to study API release from semisolid formulations to predict in vivo performance [1]. United States Pharmacopeia [2] details the Franz cell diffusion-based evaluation of a topical formulation. In this method, a topical formulation is administered into a donor chamber and permeation or diffusion is evaluated by quantifying the concentration of the drug in the receptor chamber. This traditional permeation quantification method requires measurements of the small test samples from the bulk solution through a UV spectrophotometry technique. This can be labour intensive and prone to human errors.

There is a need for real-time monitoring methodologies that can determine and provide insights into the permeation events more precisely. This need has led to the development of a novel cell defined in this poster that allows a non-intrusive real time UV imaging across synthetic membranes to characterise the permeation of a topical formulation. This was achieved using a second generation dissolution imaging instrument (SDI2). The authors are currently not aware of any work in developing a Franz set-up that allows UV imaging permeation events in real time.

Aims and Objectives

Aim

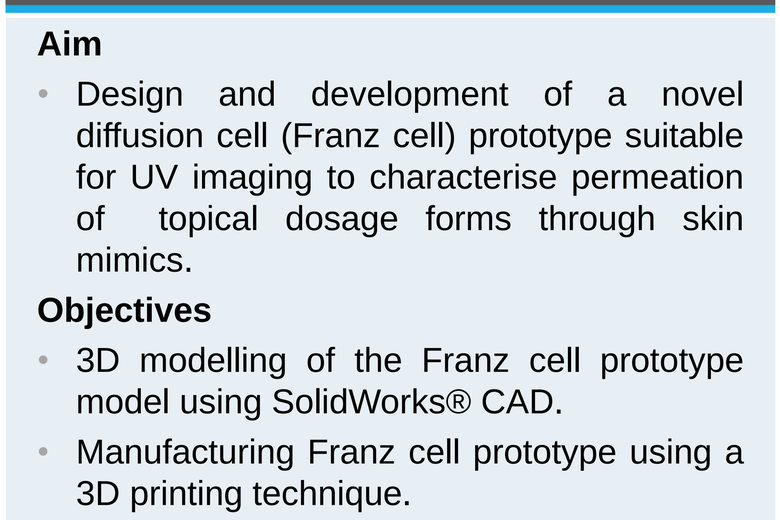
- Design and development of a novel diffusion cell (Franz cell) prototype suitable for UV imaging to characterise permeation of topical dosage forms through skin mimics.

Objectives

- 3D modelling of the Franz cell prototype model using SolidWorks® CAD.
- Manufacturing Franz cell prototype using a 3D printing technique.
- Testing manufactured prototype by using UV imaging for possible improvements.

Design

Franz cell prototype CAD model



(Patent protected)

Figure 1. 3D CAD model of the assembled cell a) Front view of Franz cell prototype with dosage tube, magnetic stirrer and stand b) Side view of the prototype

Methods

Prototype cell UV assessment

A 20 x 20 mm (H × L), 0.13 mm thick Silatos™ silicone membrane was placed in a glass beaker. Next, approximately 40 mL of phosphate buffer (pH 7.2) was added to the beaker. The beaker containing the membrane and buffer was then placed in a sonic bath for 10 min to degas and then placed in a water bath at 37 °C to equilibrate for another 20 min. Before the UV assessment, the lower receptor compartment of the cell was filled with approximately 30 mL of degassed phosphate buffer (pH 7.2) using a syringe. Next, the silicone membrane of thickness 0.13 mm was placed on a divider between the donor and receptor compartments providing a diffusion area of 3.14 cm^2.The membrane was sandwiched between the aligner and the Franz cell divider.

A method was constructed using the SDI2 data collection software to record data using the 255 nm LED to quantify drug absorbance for 12 h at 37 °C. First the cell was secured in the SDI2 UV imager to blank the system for setting a benchmark value for the UV absorbance. After blanking, the donor compartment of the cell was filled with approximately 1 mL of the ibuprofen gel administered using a 5 mL syringe The whole assembly containing the IBU gel was placed in the SDI2 UV imager (Figure 2). The magnetic stirring system was turned on and the speed set to 600 rpm. The experiment was conducted for 12 h in triplicate.

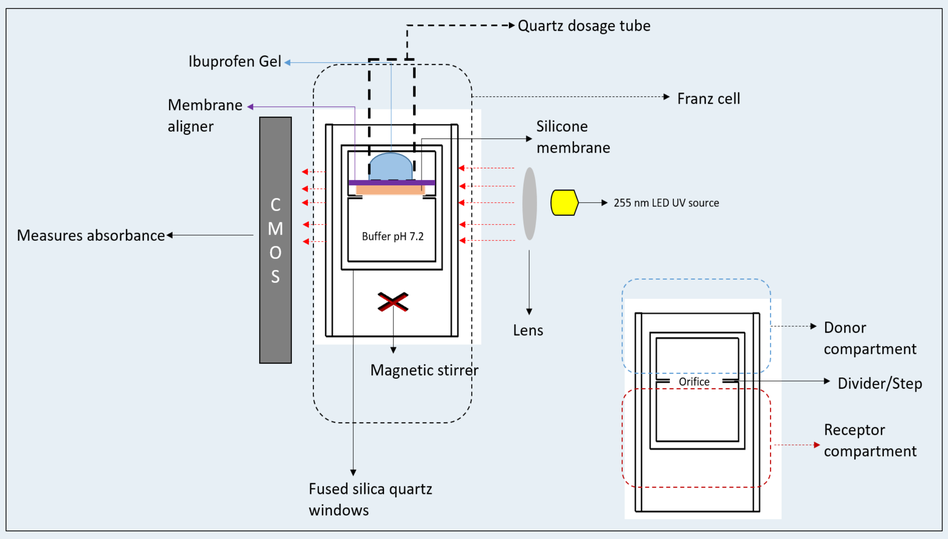


Figure 2. Schematic of the setup to quantify the amount of IBU permeating through a silicon membrane.

Results and Discussion

The analysis software supplied with the SDI2 system was used to set up a measuring zone to extract the permeation data (Figure 3). The permeation absorbance data was processed using calibration curve determined from the manufactured prototype. The absorbance readings at 30 s intervals were extracted from the software. Figure 5 depicts the UV images obtained from the permeation of IBU from the gel formulation for up to 12 h. There is a gradual increase in IBU concentration over the 12 h period. This is also represented as Figure 5 where the IBU concentration permeation is plotted as a function of time.

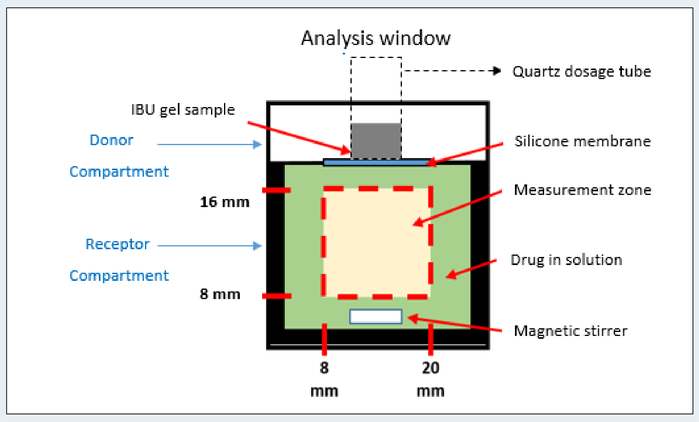


Figure 3. UV images measuring zone.

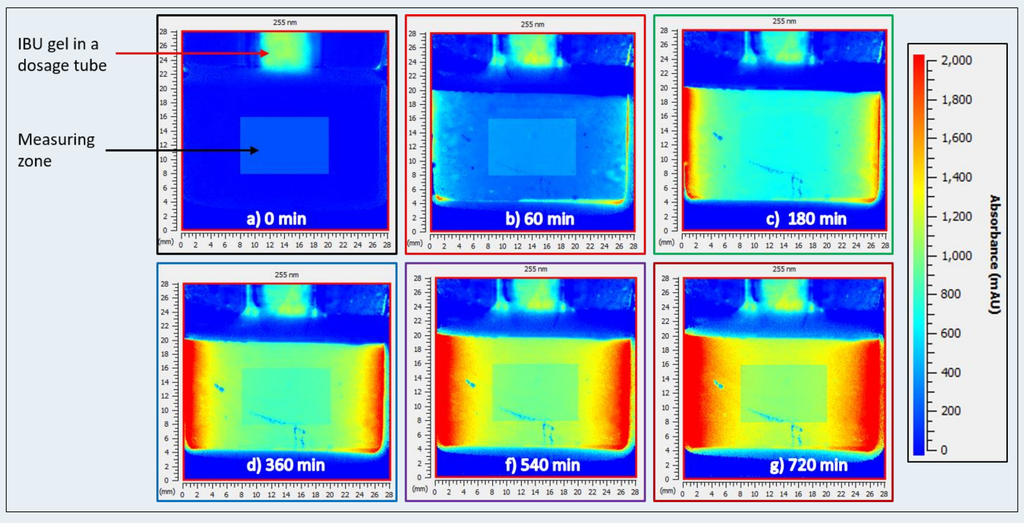


Figure 4. UV images of the Franz prototype ibuprofen permeation at 255 nm. Images colour coded with reference to Figure 5.

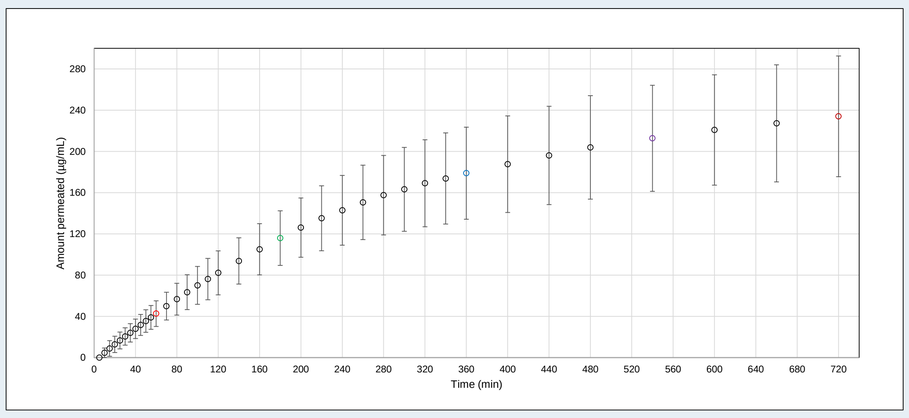


Figure 5. Average ibuprofen amount in µg/mL permeated vs time. Coloured points from red correlate with images from Figure 4.

Conclusion

- A novel permeation cell was successfully developed which facilitated real-time UV characterisation of IBU permeation from a model topical formulation.
- The UV imaging capability of the novel permeation cell allowed the quantification of drug release without the need of manual sampling and therefore providing a relatively autonomous way of gaining additional visual insights from the permeation process

References

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2. United States Pharmacopeial C, United States Pharmacopeial Convention. Council of E. The United States pharmacopeia [and] The national formulary, 2018: Volumes 1-5. USP: forty-first revision ; NF: thirty-sixth ed. Rockville, Maryland: United States Pharmacopeial Convention; 2017.

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