There are a number of different smoking machines and exposure chamber combinations used by the industry to assess the toxicological impact of cigarette smoke in vitro. However, the amount of smoke delivered to cells within an in vitro exposure system can be presented in many ways: total smoke delivered, total particulate dose delivered, total mass delivered, total particulate mass delivered, total particulate mass deposited, number of deposited particles, etc. The range of values reported varies widely between different technologies and exposure systems.

There is a need for a common approach to dosimetry, preferably using a standard or widely accepted method. The quartz crystal microbalance (QCM) technology is a versatile and simple tool that can accurately quantify the amount of particulate deposited in real-time. We can demonstrate that QCM technology is a powerful, accurate and simple tool that can accurately quantify the amount of particulate deposited in real-time. The range of values reported varies widely between different technologies and exposure systems.

The proposed approach using quartz crystal microbalance technology is a proposed common approach using quartz crystal microbalance technology.

A proposal common approach using quartz crystal microbalance technology

Dosemetric assessment of whole smoke particulate deposition in vitro.

We can demonstrate that QCM technology is a powerful, accurate and simple tool that can quantify the amount of particulate deposited in real-time. The range of values reported varies widely between different technologies and exposure systems.

The proposed approach using quartz crystal microbalance technology is a proposed common approach using quartz crystal microbalance technology.
INTRODUCTION

There are a number of different smoking machines and exposure chamber combinations used by the tobacco industry to assess the toxicological impact of cigarette smoke in vitro. Dosimetry – the quantifiable amount of smoke to which cells are directly exposed – is becoming increasingly important in the field of tobacco smoke assessment in vitro. Dosimetry tools such as the quartz crystal microbalance (QCM) could help bridge the gap between different technologies and allow cross-platform comparisons.

Exposure systems

Exposure systems comprise a smoking machine coupled with an exposure chamber that houses cell cultures. The smoking machines dilute smoke to obtain a cellular dose-response but the ‘dose’ can be presented in many different ways. Dosimetry tools that accurately measure dose are key to linking biological effects of whole smoke. BAT employ two set-ups: the RM20S with 4 QCMs in the 6/4 CF Stainless module (Figure 1). The RM20S uses a syringe serial dilution technique to achieve the desired dose, presented as 1:X (smoke:air, v:v). The VC 10 dilution principle is based on continuous flow, where diluting air and turbulent flow are used to create the desired dose, which is then sampled into the module.

Quartz Crystal Microbalance (QCM)

A small, sensitive weighing scale able to measure changes in mass in the nanogram range, the QCM can measure smoke dose in real-time. Historically, the QCM has been used to quantify environmental smoke, pollution and dust, as well as inhalation toxicity assessment of aerosols and engineered nanoparticles in vitro [1].

METHODS

* The QCM (Vitrocell® Systems, Germany) read at a resolution of 10 ng/cm²/s and during exposure recorded mass every 2 seconds [2].
* The QCM was able to quantify a dose range on the RM20S between 1:1-1:400 (smoke:air, v:v), with particle deposition of 28.0-0.2 µg/cm² (Figure 3).

RESULTS

- Using identical QCM units in different exposure chambers we were able to record real-time deposition data for the first time (Figure 2) [3].
- The QCM also enabled a comparison of particulate dose delivered from two different exposure systems.
- The QCM was able to quantify a dose range on the RM20S between 1:5-1:400 (smoke:air, v:v), with particle deposition of 8.7-0.7 µg/cm² (Figure 3).
- For the VC 10 diluting airflows of 0.25-4.0 L/min, a range of 16.7-0.7 µg/cm² particle deposition was detected by the QCMs (Figure 3).

CONCLUSIONS

We have demonstrated that QCM technology is a reliable, effective and simple tool that can accurately quantify smoke particulate deposition in real-time, in vitro. Additionally, QCM data can be used to unify in vitro toxicological data irrespective of exposure system, as demonstrated here. In summary, QCMs offer the following:

- **Real-time**
- **Sensitive (ng/cm²)**
- **No analytical resource**
- **Easy to use, train and transfer**

REFERENCES