Combination of iCVD and porous silicon for the development of a controlled drug delivery system

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Keywords: iCVD, pH-responsive, porous silicon, drug release.

Supporting Information

Modelling of drug release behavior

Zero-order kinetics describes a system where the drug release rate is independent of its concentration of the dissolved substance. The equation for zero order release is shown below in eq. (1).

$$\mathbf{Q_t = Q_0 + K_0 t} \qquad \mathbf{(1)}$$

where Q_0 = initial amount of drug Q_t = cumulative amount of drug release at time "t", K_0 = zero-order release constant t = time in hours. Hence if a graph of time vs. the cumulative percentage of drug release gives a straight line then the release can be said to follow zero-order kinetics. A delivery system that follows a zero-order release profile (constant amount of drug per unit of time) is typically suitable for drug release with prolonged pharmacological action.[1]

With first order kinetics the rate of the reaction depends on the concentration of only one reactant, and is proportional to the amount of the reactant. The first order release equation is shown below in eq. (2).

$$\mathbf{\text{Log } Q_t = \text{Log } Q_0 + K_t/2.303} \qquad \mathbf{(2)}$$

where Q_0 = initial amount of drug Q_t = cumulative amount of drug release at time "t", K = first order release constant and t = time in hours. If a graph of the time vs. the log cumulative percentage of drug remaining to be released gives a straight line then first order kinetics are followed. Essentially release platforms that follow this kinetic model will release drugs in a manner that is proportional to the amount of drug

remaining in the system. Another way of putting this is that the amount of drug released diminishes over time as the drug is released from the system.[1]

The Hixson-Crowell release equation is an empirical equation which describes the drug release by dissolution and changes in surface area of the drug delivery matrix.[2] The Hixson-Crowell release equation is shown below in eq. (3).

$$(Q_0)^{1/3} - (Q_t)^{1/3} = k_{HC}t \qquad (3)$$

Where K_{HC} = Hixson-Crowell release constant. A plot of the cube root of the initial concentration minus the cube root of percent remaining *vs.* time in hours should be linear if this model is obeyed.

The Higuchi model is an empirical model commonly used to describe the release kinetics of drugs from insoluble porous materials.[3] It is well established and commonly used for modeling drug release from matrix systems. The model is based on a square root of a time dependent process of Fickian diffusion (eq. (4)).

$$Q_t = k_H t^{½} \qquad (4)$$

In this model, the plot of % drug released (Q_t) *vs*. the square root of time should be linear for a purely diffusion controlled process with the slope of the plot equal to the Higuchi release rate constant k_H.[4] Deviations from linearity indicate that the release is not purely diffusion controlled, and may be influenced by other factors, such as the degradation of the matrix material.

The Ritger-Peppas model is used to fit drug release profiles from polymeric thin films, cylinders and spheres.[5] The Ritger-Peppas model can be applied to any system to gain an idea of the apparent overall release phenomenon regardless of the specific mechanisms of release actually occurring.[5] The Ritger-Peppas model is limited to the first 60% of a drug release curve only; diffusion must be one-dimensional (aspect ratio is at least 10/1) and the drug diffusion coefficient must be concentration independent. These conditions are met for most materials in this study. The Ritger-Peppas equation is shown below in eq. (5).[5]

$$(M_t/M) = K_m t^n \qquad (5)$$

Where M_t = amount of drug released at time t, M = total amount of drug in dosage form, K_m = kinetic constant and n = release exponent. The n exponent is estimated from the slope of log (M_t/M) versus log time.

Higuchi Plots

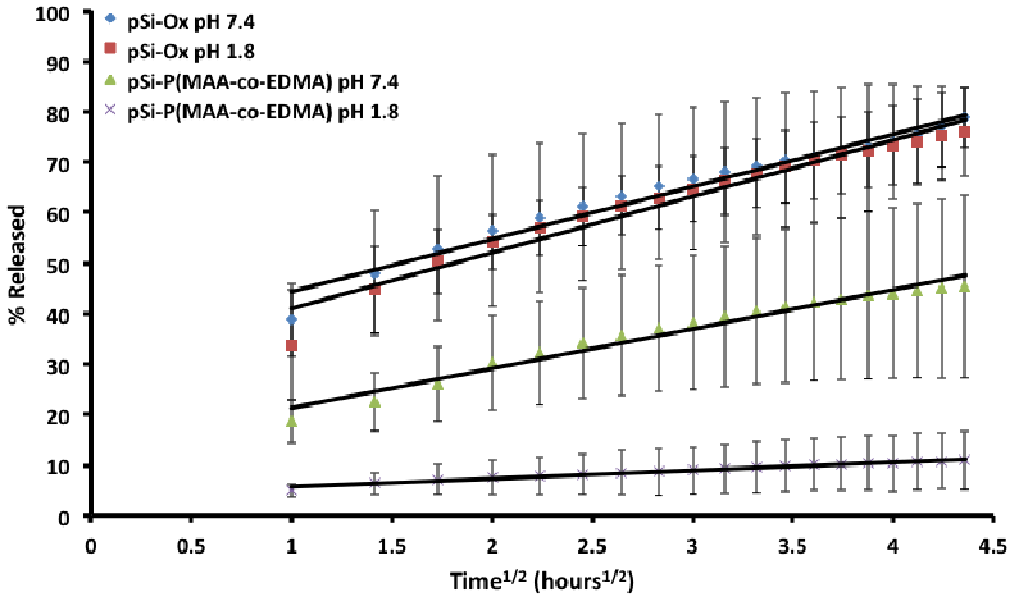

Figure S1: Higuchi drug release curves for CPT from uncoated oxidized pSi (pSi-Ox) and after coating with p(MAA-co-EDMA) at a pH of 1.8 and 7.4, respectively (n ≥ 3). The R^2 values are 0.993 and 0.990 for pSi-Ox and pSi-Ox coated with p(MAA-co-EDMA) at pH 7.4 and 0.983 and 0.997 for pSi-Ox and pSi-Ox coated with p(MAA-co-EDMA) at pH 1.8.

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