# Humidity-Triggered Self-Healing of Microporous Polyelectrolyte Multilayer Coatings for Hydrophobic Drug Delivery


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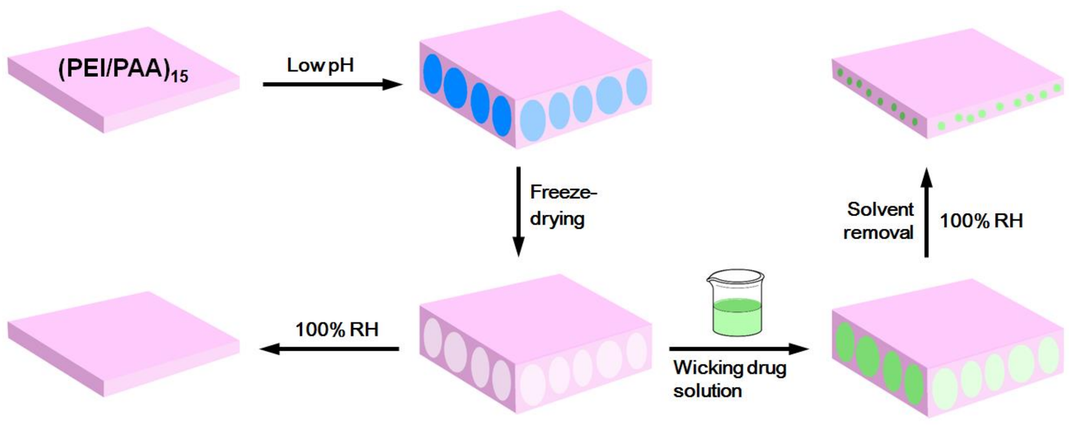
## Introduction

Over the past decades, local delivery of therapeutics has shown its unique characteristics and prominent advantages in relieving undesired side effects and improving curative effects. Layer-by-Layer (LbL) self-assembly, based on alternating deposition of interacting species on substrates, has typically emerged as a striking tool to engineer drug delivery systems (DDSs) with controlled structure and composition. As for the delivery of hydrophobic drugs, the limitation of those existing LbL strategies lies in the problems associated with chemical synthesis and complicated operations.

LbL self-assemblies have inherent potential as dynamic coatings because the interactions between building blocks could be easily modulated by electric field, pH, high salt concentration, light, etc. Herein, we demonstrated that humidity can serve as a feasible trigger to activate the self-healing of microporous polyethylenimine/poly (acrylic acid) (PEI/PAA) multilayer film. Based on this, a facile and versatile means is suggested to directly integrate hydrophobic drugs into the films for biomedical coatings.

## Method




***Scheme 1.*** *Fabrication of dynamic polyelectrolyte multilayer (PEM) film with self-healing microporous structures and integration of hydrophobic drug into the film.*

## Results and Discussion

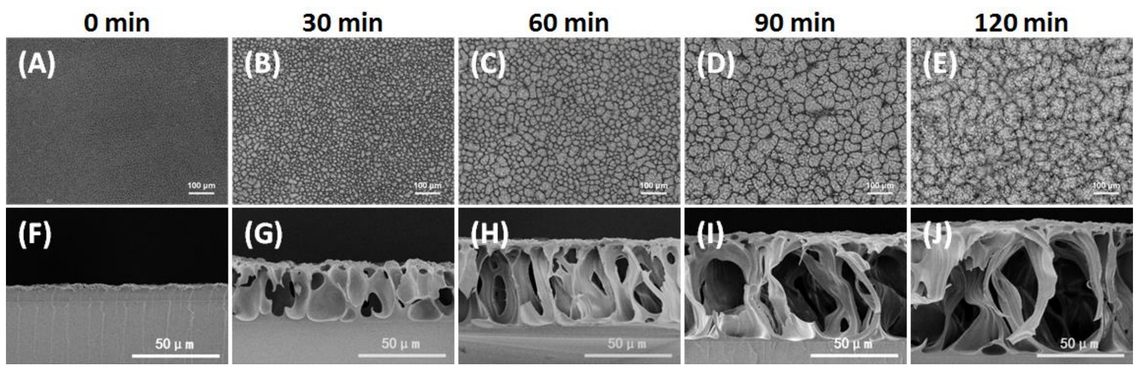



***Figure 1.*** *Acid-induced structural evolution of $(PEI/PAA)_{15}$ films over time. Optical microscopy images (A-E) and SEM cross-sectional images (F-J) of the PEM films after immersion in pH 2.9 for various times. Freeze-drying was performed to remove water before SEM examination. The default immersion time was set to 60 min in the study of drug delivery.*

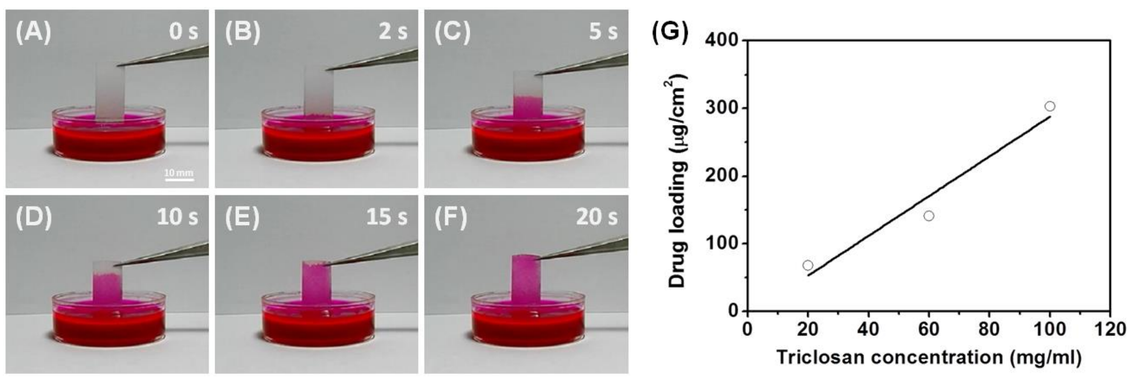



***Figure 2.*** *(A-F) Nile red, a hydrophobic dye, could be loaded into the microporous PEM film by wicking from its ethanol solution, indicating the presence of abundant open pores across the whole film. (G) Plot of actual triclosan loading with respect to the concentration of triclosan-ethanol solution.*

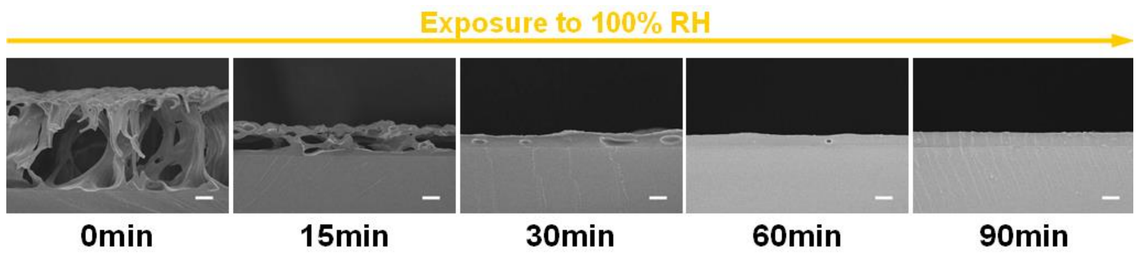



***Figure 3.*** *SEM cross-sectional images of the healing process of the microporous PEM film. All of the inset scale bars represent 10 μm.*

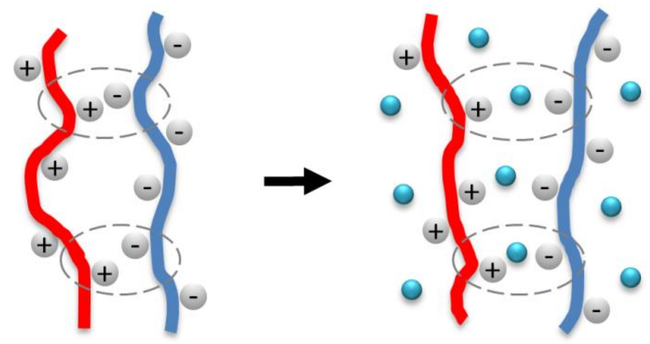


***Figure 4.*** *Simplified mechanism of how the water uptake affects the interactions between PEI and PAA. The effect of water can significantly disrupt the cross-linked network and activate the motion of the whole polymer chains. The red line and the blue line respectively represent PEI and PAA; the blue dots correspond to the water molecules within the film.*

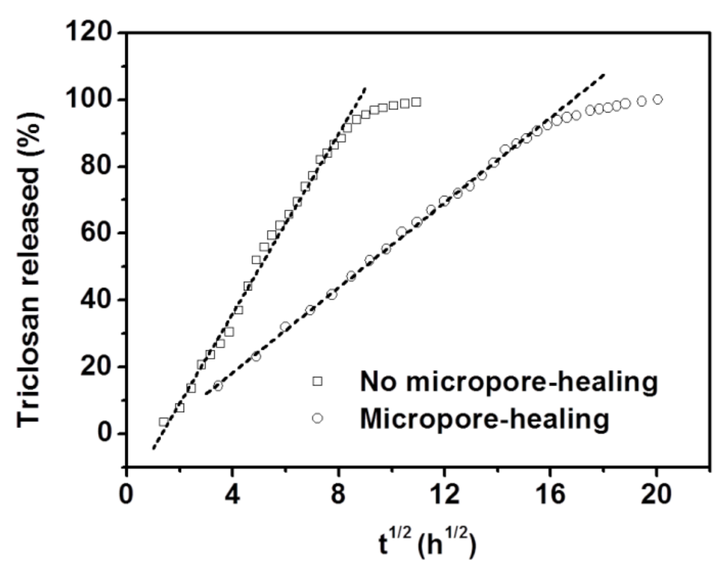



***Figure 5.*** *Release profiles of triclosan from the drug-loaded PEM films without (A) and with (B) micropore-healing. The linear relationships between the drug releasing percent and the square root of the releasing time at the early stage indicated that the drug releases followed a Fickian diffusion mechanism. The closure of those microporous structures is favorable for the sustained release of drugs.*

## Conclusion

The high porosity of microporous films enables the highest loading (~303.5 μg/cm² for a 15-bilayered film) of triclosan to be a one-shot deal via wicking action and subsequent solvent removal, thus dramatically streamlining the processes and reducing complexities compared to the existing LbL strategies. The self-healing of drug-loaded microporous PEM film reduces the diffusion coefficient of triclosan by two orders of magnitude, which is favorable for the long-term sustained release of drug. The dynamic properties of this polymeric coating provide great potential as delivery platform of hydrophobic drugs for a wide variety of biomedical applications. More importantly, this dynamic strategy could provide a new thought about construction of drug releasing polymeric coatings since self-healing is a common phenomenon of many polymers.

## Reference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