$CuSO_4/H_2O_2$-Induced Rapid Deposition of Polydopamine Coatings with High Uniformity and Enhanced Stability

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Mussel-inspired polydopamine (PDA) deposition offers a promising route to fabricate multifunctional coatings for various materials. However, PDA deposition is generally a time-consuming process, and PDA coatings are unstable in acidic and alkaline media, as well as in polar organic solvents. We report a strategy to realize the rapid deposition of PDA by using $CuSO_4/H_2O_2$ as a trigger. Compared to the conventional processes, our strategy shows the fastest deposition rate reported to date, and the PDA coatings exhibit high uniformity and enhanced stability. Furthermore, the PDA-coated porous membranes have excellent hydrophilicity and antibacterial performance. This work demonstrates a useful method for the environmentally friendly, cost-effective, and time-saving fabrication of PDA coatings.

Polymerization of dopamine

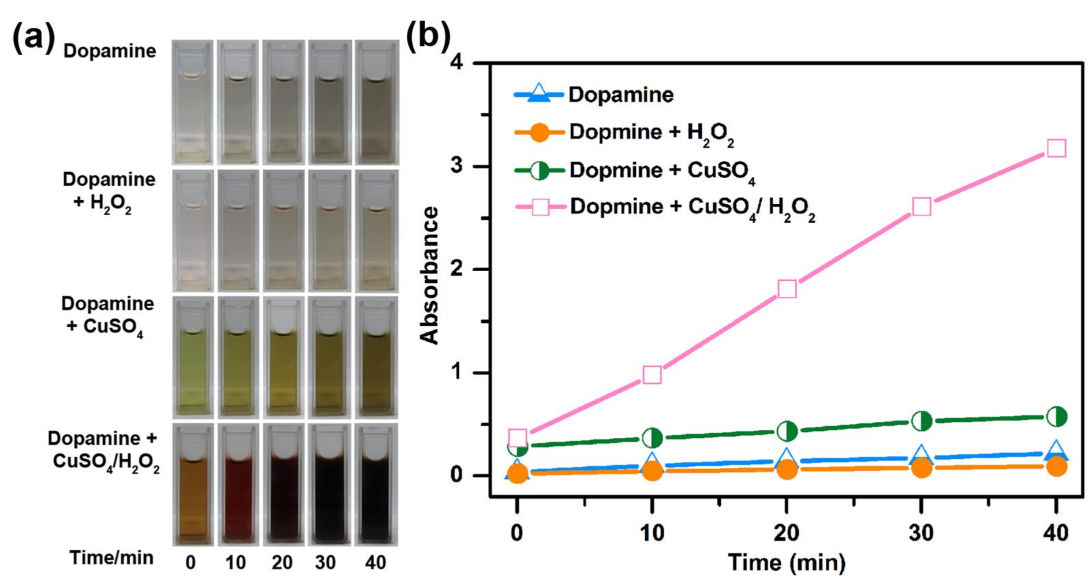

Figure 1. a) Photographs of original dopamine solutions with various additives ($CuSO_4$: 5 mM; H_2O_2: 19.6 mM) at different time points. b)Time-dependence of absorbance at 420 nm for various diluted dopamine solutions.

Deposition of polydopamine

Table 1 Thicknesses of PDA coatings deposited with different methods.

Condition	Time (h)	Thickness (nm)	Thickness/Time (nm/h)
Air, pH 8.5	24.0	50.0	2.1
Pure O_2, pH 8.5	0.5	4.4	8.8
UV, pH 8.5	2.0	4.0	2.0
$K_2S_2O_8$, pH 7.0	2.0	70.0	35.0
$CuSO_4$, pH 8.5	80.0	70.0	0.9
$CuSO_4/H_2O_2$, pH 8.5	0.7	30.1	43

Compared with the thicknesses of various PDA coatings, our $CuSO_4/H_2O_2$-triggered method showed the fastest deposition rate at room temperature, 43 nm/h, as high as 10 times than that of conventional methods oxidized by air.

Stability of polydopamine coatings

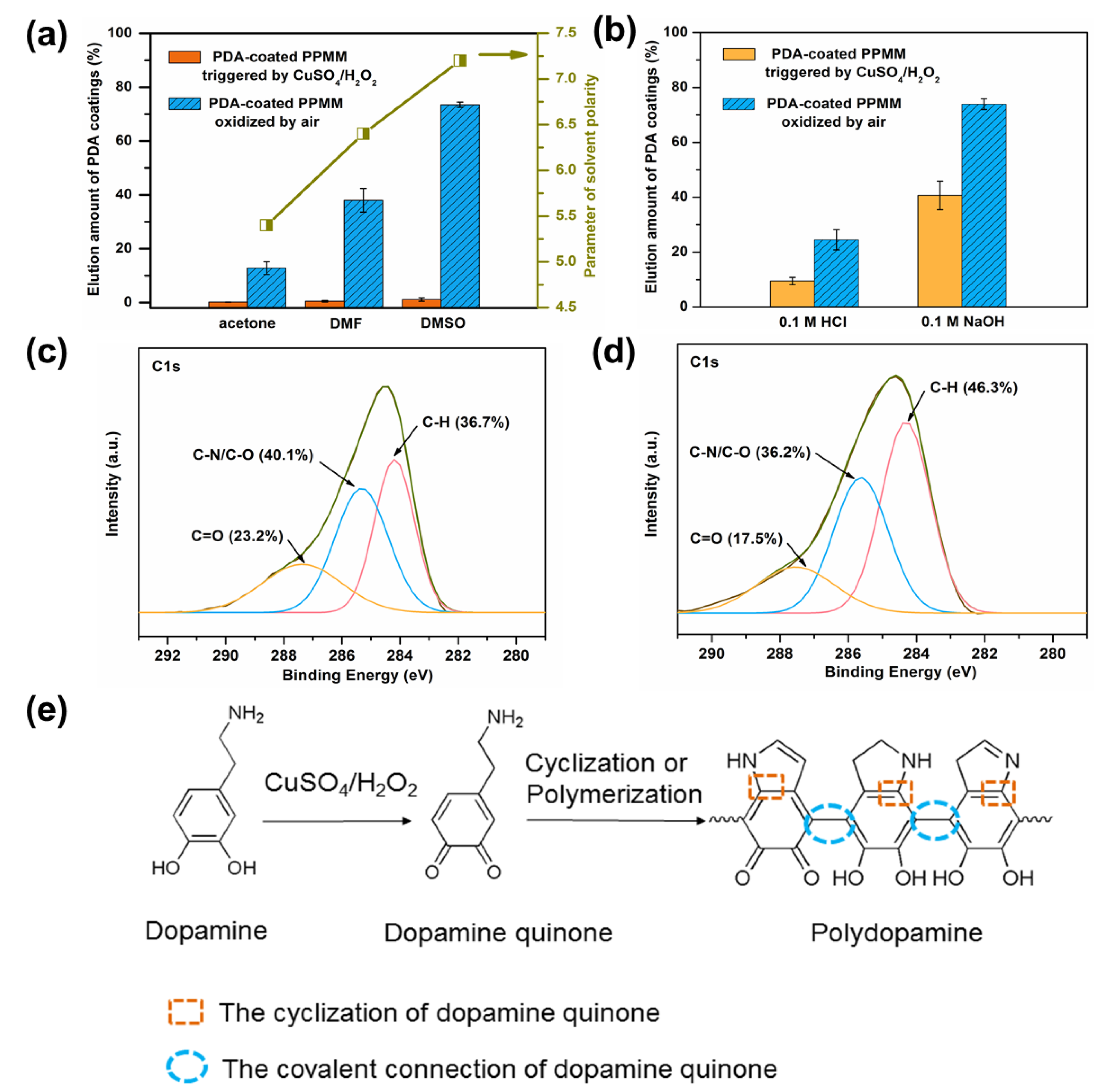

Figure 3. a) and b) Elution amount of the PDA-coated PPMMs immersed in different solutions. c) High-resolution XPS spectra of PDA coatings on silicon wafer triggered by $CuSO_4/H_2O_2$ for 40 min. d) High-resolution XPS spectra of PDA coatings on silicon wafer oxidized by air for 12 h. e) Illustration of the reduction of C-H during the process of dopamine polymerization.

Uniformity of polydopamine coatings

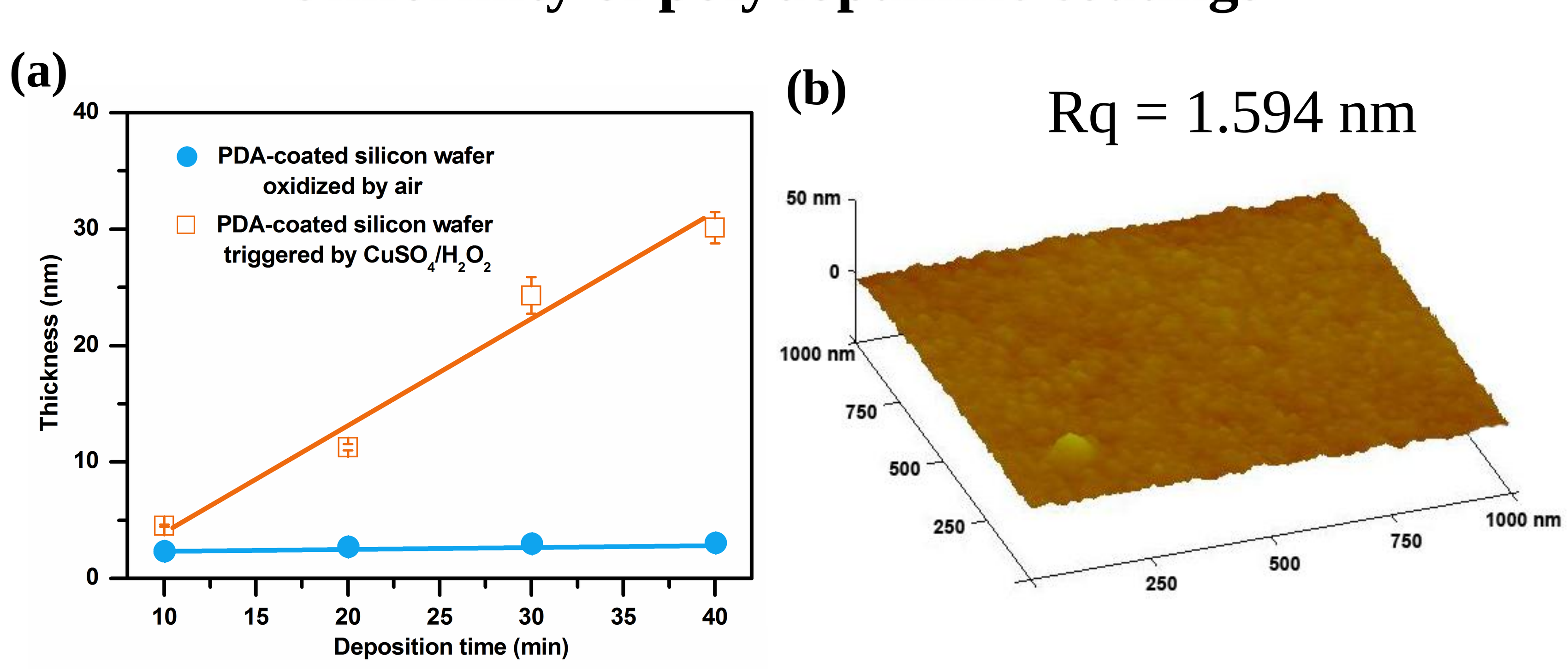

Figure 2. a) Time-dependence of thickness for the PDA coatings deposited on silicon wafers, as determined by ellipsometry. b) AFM images of the PDA-coated silicon wafer triggered by $CuSO_4/H_2O_2$ for 40 min.

Application of polydopamine coatings

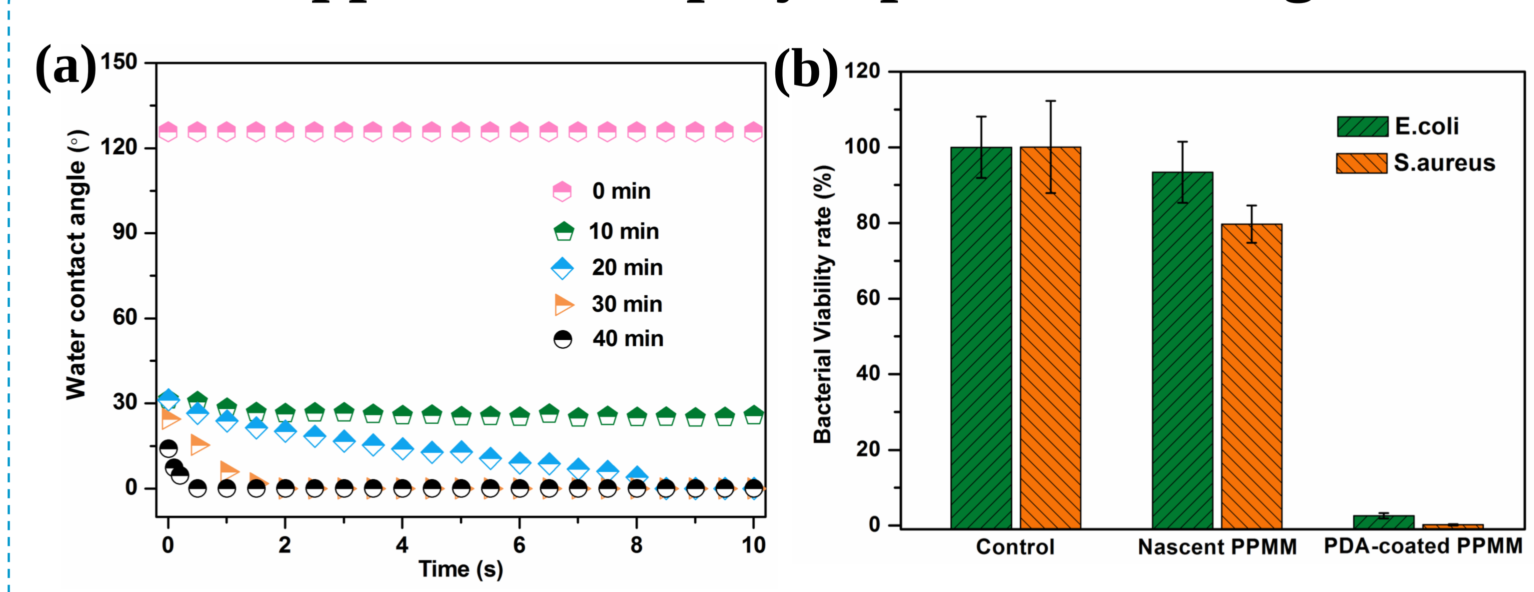

Figure 4. a) Water contact angle of the PDA-coated PPMMs triggered by $CuSO_4$ (5 mm)/H_2O_2 (19.6 mm) for different times. b) Antibacterial activity of the nascent PPMM and the PDA-coated PPMM by 40 min rapid deposition with $CuSO_4/H_2O_2$ triggering.

Conclusions:

In summary, we have developed a useful method for the fast polymerization of dopamine and the rapid deposition of PDA coatings on various substrates. The $CuSO_4/H_2O_2$-triggered PDA coatings possess high uniformity and enhanced stability. In addition, this rapid deposition is effective for the surface modification of porous membranes, which show excellent hydrophilicity, high water permeability, and outstanding antibacterial performance.

Reference:

(1) Zhang, C., Ou, Y., Lei, W. X., Wan, L. S., Ji, J., Xu, Z. K. *Angew. Chem. Int. Ed.* **2016**, *55*, 3054 –3057.

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