Electronic Supplementary Information (ESI)

Quantitative detection of near-infrared (NIR) light using organic layered composites

Machi Takeuchi,[a] Hisato Kawashima,[b] Hiroaki Imai,[a] Syuji Fujii,[c,d]* and Yuya Oaki[a]*

[a] Department of Applied Chemistry, Faculty of Science and Technology, Keio University, 3-14-1 Hiyoshi, Kohoku-ku, Yokohama 223-8522, Japan.

[b] Division of Applied Chemistry, Graduate School of Engineering, Osaka Institute of Technology, 5-16-1 Omiya, Asahi-ku, Osaka 535-8585, Japan

[c] Department of Applied Chemistry, Faculty of Engineering, Osaka Institute of Technology, 5-16-1 Omiya, Asahi-ku, Osaka 535-8585, Japan

[d] Nanomaterials Microdevices Research Center, Osaka Institute of Technology, 5-16-1 Omiya, Asahi-ku Osaka 535-8585, Japan.

*E-mail: syuji.fujii@oit.ac.jp, oakiyuya@applc.keio.ac.jp

Contents

Photographs of the PDA-coated paper with irradiation of NIR

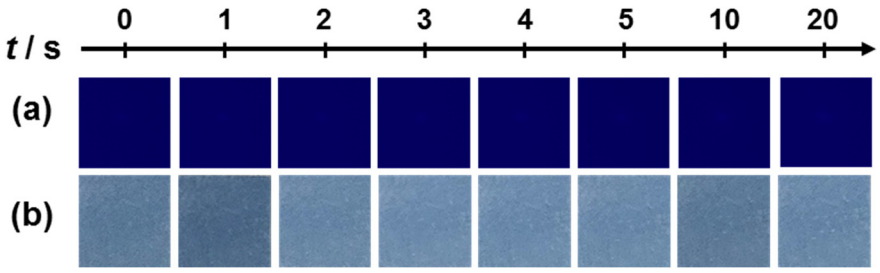

Fig. S1. Thermography images (a) and photographs (b) of the PDA-coated paper with irradiation of NIR (50 mW).

No color changes were observed on both the thermography images and photographs. The temperature was not increased on the PDA-coated paper without PPy coating. In addition, PDA itself had no absorption in the NIR range (Fig. 2d). The results indicate that the coating of PPy with photothermal properties is required for stimulus conversion from NIR to heat. The color of the thermography image was not different between the inside and outside areas of the paper device. It means that the temperature of the PDA-coated paper without PPy was the same as room temperature around 25 °C.

SEM images of the PDA-coated paper

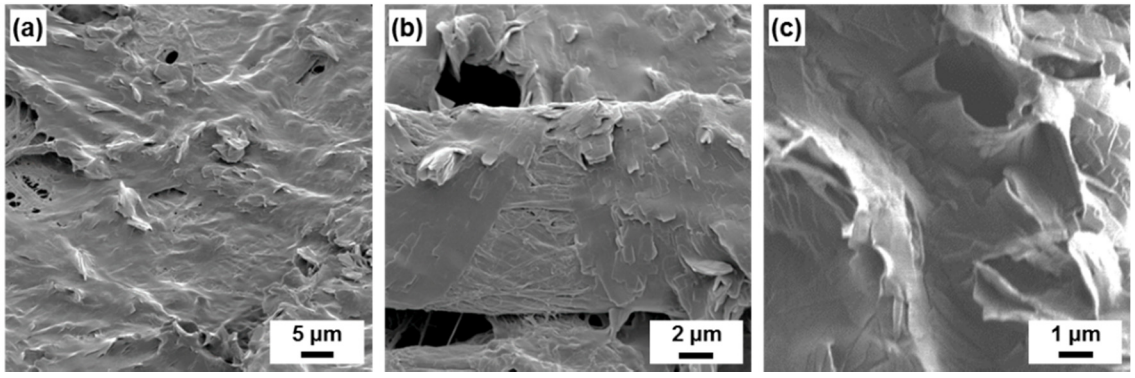

Fig. S2. SEM images of the PDA sheets coated on a filter paper.

The PDA sheets have 1–10 μm in lateral size and less than 100 nm in thickness on a filter paper. The bundles of cellulose fibrils were covered with the PDA sheets.

SEM and EDX analysis of the PDA-Zn^{2+}-coated paper

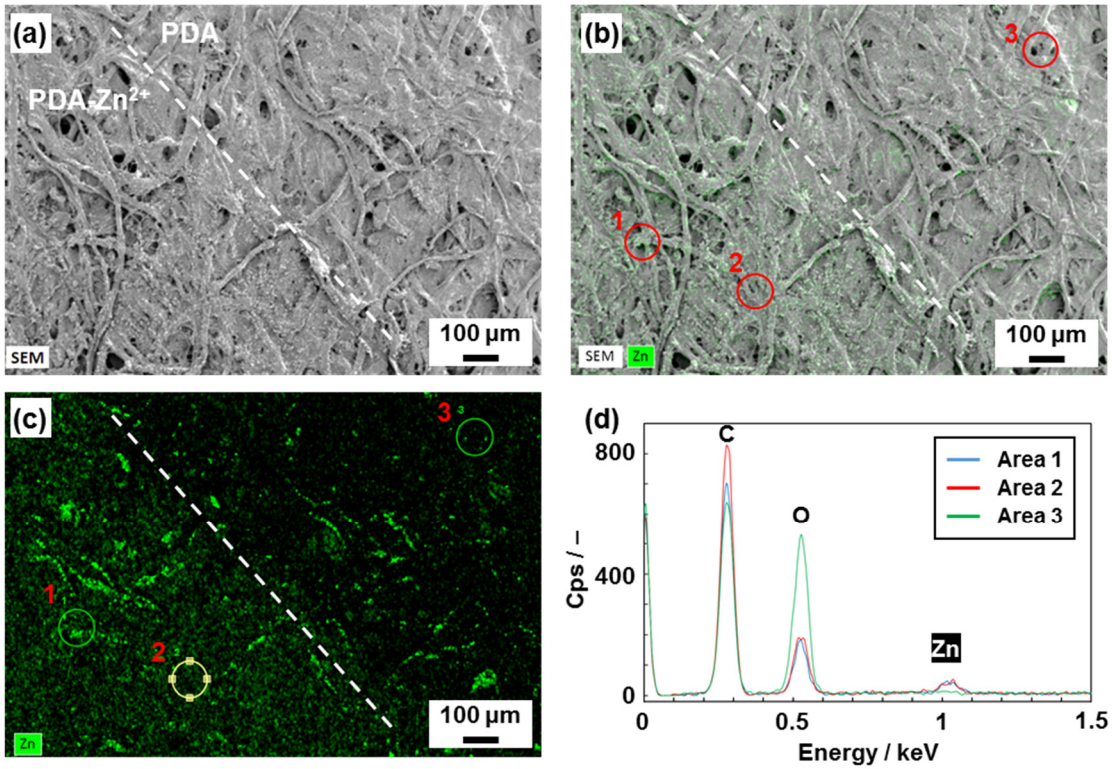

Fig. S3. SEM images with EDX elemental mapping of the PDA-Zn^{2+}-coated paper. (a) SEM image of the paper at the interface (white dashed line) between the Zn^{2+}-intercalated PDA (bottom left) and original PDA domains (top right). (b) SEM image combined with EDX elemental mapping by Zn (green colors). (c) EDX elemental mapping by Zn^{2+}. (d) EDX spectra of the areas 1, 2, and 3 in the panels (b) and (c). The panels (a-c) and spectra (d) were obtained in the same area.

The PDA-coated paper was partially dipped in the solution containing Zn^{2+}. The partial intercalation of Zn^{2+} was performed at the interface indicated by the white dash line (Fig. S3a–c). The presence of Zn was mainly detected on the bottom-left part of the image (Fig. S3b,c), even though smaller amount of Zn was contaminated on the top-right part. The EDX spectra were measured at the areas 1, 2, and 3 in Fig. S3b. Whereas the peak of Zn was detected on the areas 1 and 2, the peak was not observed on the area 3 (Fig. S3d).

Thickness of the PPy-coating layer

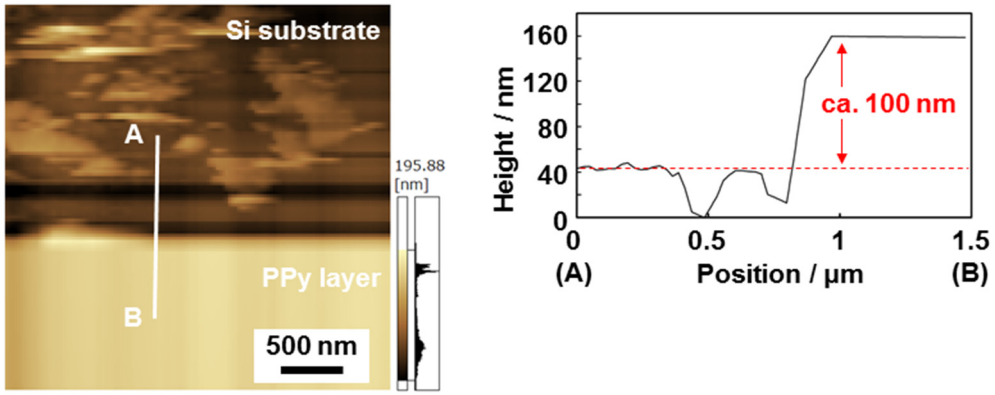

Fig. S4. AFM image and its height profile of the PPy thin layer coating on a silicon substrate for 15 min at 40 °C.

Since the thickness of the PPy thin layer on the PDA-coated paper is not easily estimated by electron microscopy techniques, the same coating was performed on a cleaned silicon substrate. Half area of a cleaned silicon substrate was masked using a tape to prevent the coating (the upper part of the image in Fig. S4). The boundary of the coated and uncoated area was observed by AFM. The thickness is estimated to be around 100 nm. The slight roughness of the uncoated area (the upper part) is ascribed to the remaining adhesive agent of masking tape.

XPS analysis of the PPy/PDA- and PPy/PDA-Zn^{2+}-coated papers

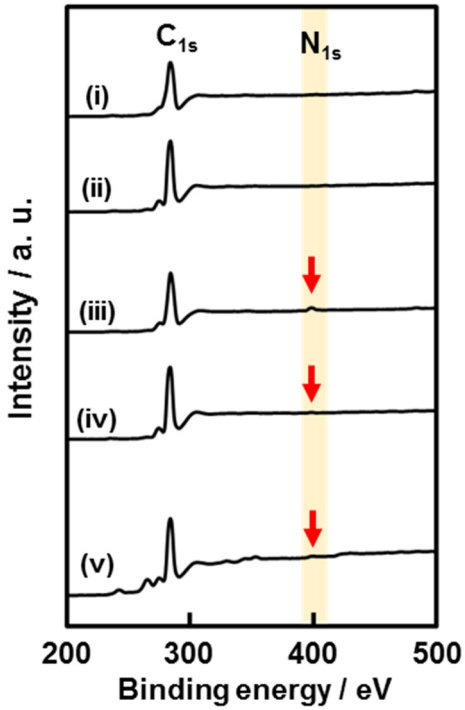

Fig. S5. XPS of a filter paper (i), PDA-coated filter paper (ii), PPy-coated paper (iii), PPy/PDA-coated paper (iv), and PPy/PDA-Zn^{2+}-coated paper (v).

The weak peak corresponding to N_{1s} was detected on the PPy-coated paper, PPy/PDA-coated paper, and PPy/PDA-Zn^{2+}-coated paper samples (the red arrows).