Supplementary Information for

One-Step Polymer Screen-Printing for Microfluidic Paper-Based Analytical Device (μPAD) Fabrication

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\textbf{Figure S-1.} Schematic diagram for analytical procedure using the fabricated paper devices for the analysis of (a) H\textsubscript{2}O\textsubscript{2} in a distance-based format and (b) antioxidant activity using DPPH assay in a well-based format.
**Figure S-2.** Gray scale intensity measurement procedure using ImageJ.

[A diagram showing the steps: original image from a scanner, color threshold adjusted with ImageJ, converted to 8-bit image, invert, wanted area selected and the intensity measured.]

**Figure S-3.** Typical devices (A) immediately after fabrication using polymer-printing method and (B) after allow to dry. Right after fabrication, the wet area where the polystyrene solution penetrate through was observed and intact paper was still dry indicating that no toluene solution leaked into the intact paper during the fabrication.
Figure S-4 The fabricated paper using Whatman #1 with polystyrene solution at the concentration of 10% (left) and 5% (right) w/v. The results showed that 10% polystyrene solution (optimal concentration) gave well-defined hydrophobic barrier on the paper while 5% polystyrene solution gave poor reproducibility of the pattern due to polystyrene solution spreading at low viscosity.
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**Figure S-5.** Solvent resistivity testing of the μPAD fabricated using polymer-printing method. The tested solvent including acetonitrile (ACN), ethanol (EtOH), methanol (MeOH) and n-hexane. The results showed no damage of the pattern after immersing the device into the studied solvents.

![Top view](image1) ![Side view](image2)

**Figure S-6.** Dropping of H$_2$O$_2$ onto a CeO$_2$-coated paper without the use of PEG. Some part of the H$_2$O$_2$ solution could wick into the paper and react with CeO$_2$ nanoparticles causing color forming. However, due to the hydrophobicity of the CeO$_2$ nanoparticles when presented as a thin film, some part of the solution still present as a drop.

**List of the chemical equations previously proposed for the reaction of H$_2$O$_2$ and CeO$_2$ nanoparticles.**

The proposed chemical equations of H$_2$O$_2$ and CeO$_2$ that could make the change of the nanoparticles color from colorless to yellow-orange are based on the change in oxidation state of mixed valence state of Ce$^{3+}$ and Ce$^{4+}$ in the nanoparticles to give more Ce$^{4+}$ oxidation state upon the addition of H$_2$O$_2$. Below are list of possible chemical equations proposed previously.

Das, M., et al$^1$ proposed the chemical equation between H$_2$O$_2$ and CeO$_2$ as follows:

$$H_2O_2 → 2(\text{HO}^-)$$

$$\text{Ce}_2O_3 + 2\text{HO}^- → 2\text{CeO}_2 + H_2O$$

The mechanisms proposed by Scholes, F. H., et al$^2$ were the formation of Ce$^{3+}$ peroxo complexes such as Ce(H$_2$O$_2$)$^{3+}$ as an initial step, followed by deprotonation, oxidation and precipitation to form peroxo-containing Ce$^{4+}$ species such as Ce$^{4+}$(O$_2$)(OH)$_2$ as follows:

$$\text{Ce}^{3+} + H_2O_2 ↔ \text{Ce}(H_2O_2)^{3+}$$

$$\text{Ce}(H_2O_2)^{3+} + \text{OH}^- → \text{Ce}(\text{HO}_2)^{2+} + H_2O$$

$$\text{Ce}(\text{HO}_2)^{2+} + \text{OH}^- → \text{Ce}(O_2)^{+} + H_2O$$

$$\text{Ce}(O_2)^{+} + \frac{1}{2}H_2O_2 → \text{Ce}(O_2)^{2+} + \text{OH}^-$$
\[ \text{Ce}(O_2)^{2+} + 2OH^- \rightarrow \text{Ce}(O_2)(OH)_2 \]

Overall reaction:

\[ \text{Ce}^3^+ + \frac{3}{2}H_2O_2 + 3OH^- \rightarrow \text{Ce}(O_2)(OH)_2 + 2H_2O \]

**Figure S-7.** Reaction scheme of DPPH radicals and antioxidant (RH). DPPH radicals is reduced by antioxidants changing its color from violet to yellow.

**References**
