

## Supporting Information

### Reinforced thermal barrier coat of Na-tannic acid complexation in the view of thermal kinetics

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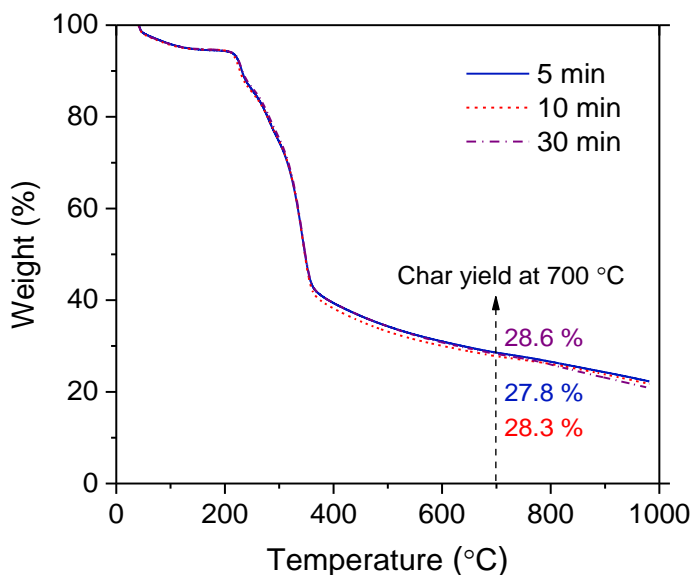
## Supplementary results

### 1. Effects of treatment condition

A scoured fabric was immersed in an aqueous solution containing 20 wt% tannic acid and 1 wt% NaOH—which had been agitated for 5 min—for 5, 10, or 30 min and passed through a laboratory padder (Werner Mathis, Concord, NC) at a pressure of 68.9 kPa (10 psi) and a padder speed of 2 m/min. The padded fabric was air-dried at room temperature or dried in the oven at 70 °C for 30 min. The TG thermograms—in the temperature range of 30 - 900 °C—of the fabrics treated under different immersion times and drying temperatures were compared using a TGA Q500 thermal gravimetric analyzer (TA Instruments) under a nitrogen atmosphere.

#### 1.1. Effect of immersion time

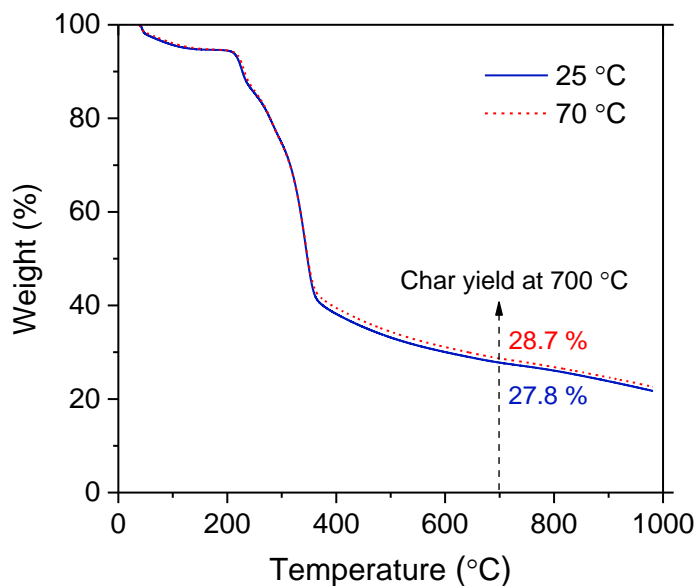
The immersion time of cotton fabric was increased up to 30 min to examine its effect on the thermal property of cotton-TN. Fig. S1 shows the TG thermograms of cotton-TN fabrics prepared with 5, 10, and 30 min of immersion time. The collected thermograms were all overlapped, and their respective char yields at 700 °C were close to each other. This result indicates that Na-tannic acid complex was readily adsorbed onto cotton for a short period of time.



**Fig. S1** Effect of immersion time on the TG thermogram of cotton-TN.

## 1.2. Effect of drying temperature

To examine any possible thermal fixation effect—by drying at a high temperature—on the thermal property of cotton-TN, the drying temperature was increased to 70 °C. Fig. S2 shows the TG thermograms of cotton-TN fabrics prepared with air-drying at room temperature and oven-drying at 70 °C. The obtained thermograms were not significantly different from each other.

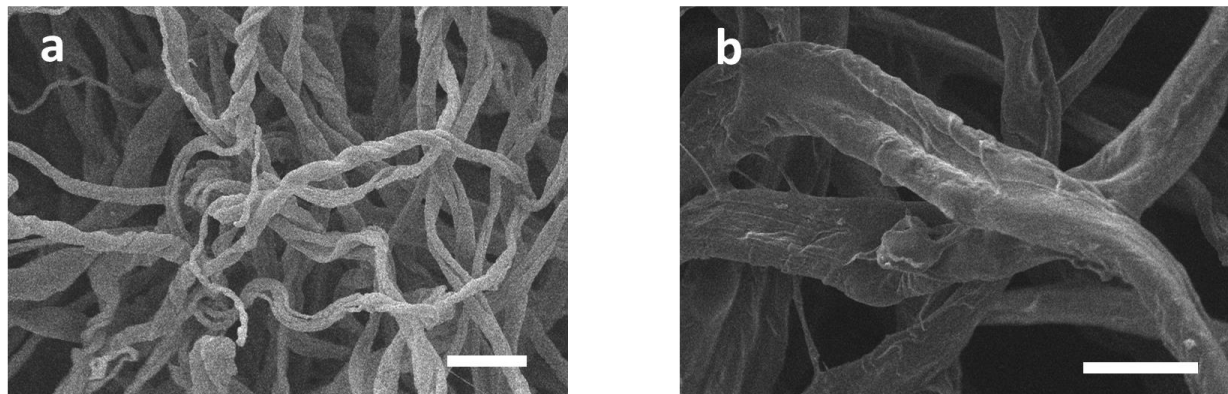


**Fig. S2** Effect of drying time on the TG thermogram of cotton-TN. The air-dry at room temperature was denoted as registering a temperature of 25 °C.

## 2. Scanning electron microscopic (SEM) images

The SEM images of charred control cotton and cotton-T fabrics were taken using an ESEM (XL 30, Phillips). A sample was heated to 400 °C—at which the major thermal decomposition of cotton cellulose ended—in the TG furnace (TGA Q500, TA Instruments) with a heating rate of 10 °C/min. The obtained char was cooled down at room temperature and coated with a gold-palladium alloy using a vacuum sputter coater. Images were taken with an acceleration voltage of 10 keV and a beam current of 0.5 nA.

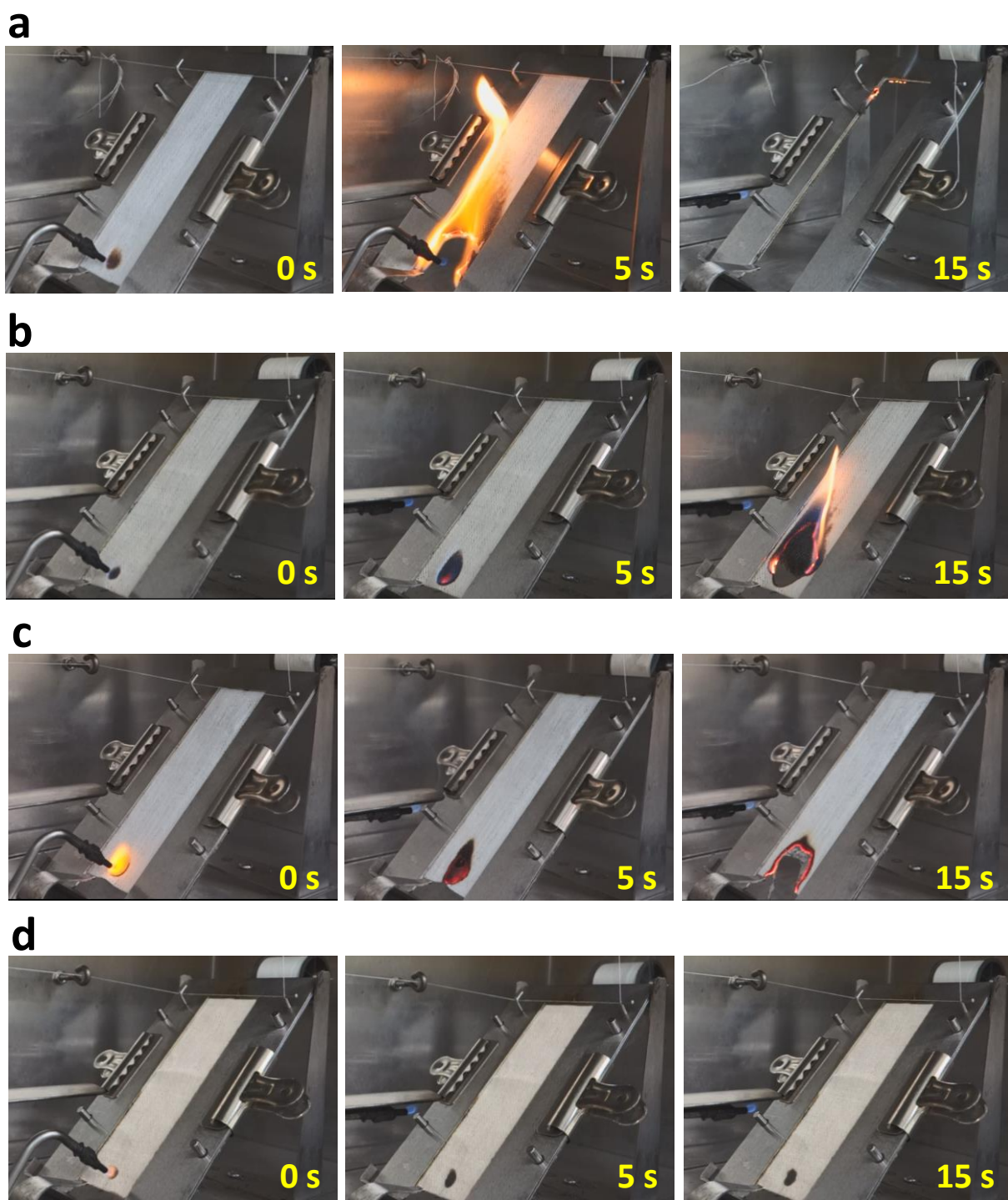
Fig. S3 shows the SEM images of the charred control cotton and cotton-T obtained at 400 °C. The control cotton fiber was severely damaged, distorted, and twisted. However, the treatment of tannic acid alone relatively well preserved the morphology and surface microstructure of cotton fiber, showing its thermal barrier function. The characteristic blown char of tannic acid was not much observed on cotton.



**Fig. S3** SEM images of the chars for (a) control cotton fiber and (b) cotton-T fiber taken at 400 °C. Scale bars are 20  $\mu\text{m}$ .

### 3. Open flame test

Flame resistance was examined using a 45° angle flammability tester (TC 45, Govmark) according to ASTM D1230-10. A standardized flame was applied to the fabric for 5 seconds. The times for the flame and glow sustaining on the fabric after removal of the flame (denoted as afterflame time and afterglow time, respectively) were measured. An average value of three measurements was presented. The burning behavior of samples during these tests was recorded using a digital camera (RX100, Sony).



**Fig. S4** Photographs of cotton-TN taken at 0, 5, and 15 seconds in the 45° angle flammability test showing no ignition.