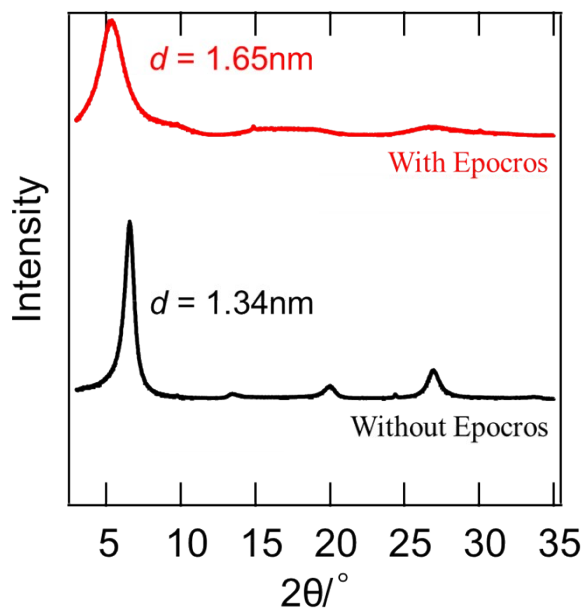


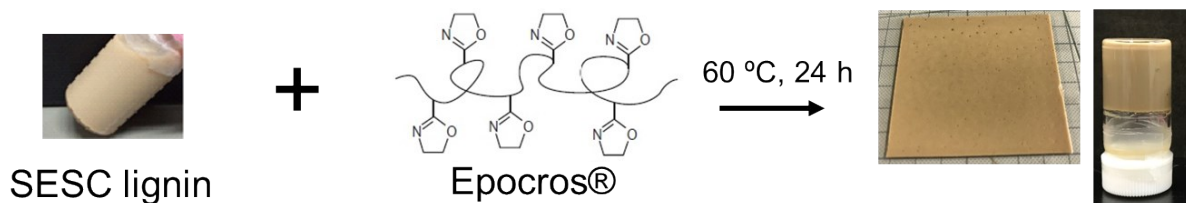
## Supporting Information

**Title** Non-flammable UV protection films consisting of clay and lignin with tunable light/gas transparency

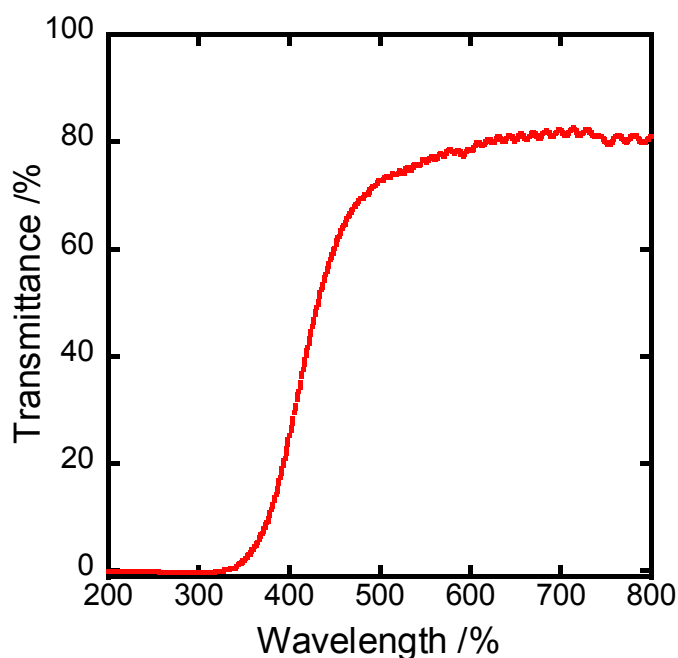
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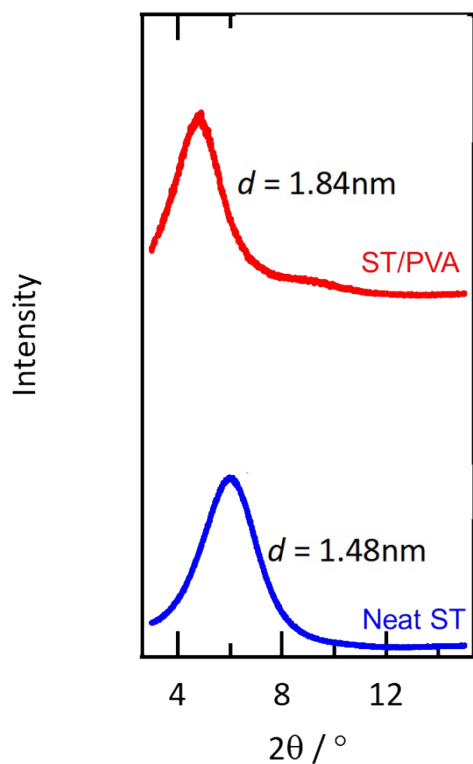
**Fig. S1.** X-ray diffraction (XRD) pattern of clay-lignin films consisting of MMT and SESC lignin without Epocros® (lower, MMT:SESC lignin = 8:2 w/w%) or with Epocros® (upper, MMT:SESC lignin: Epocros® = 7:2:1 w/w%). The lowest  $2\theta$  peak (the basal (001) reflection of the MMT) shifted to a smaller  $2\theta$  region after the addition of Epocros®. The  $2\theta$  peak of MMT was unaffected by the addition of SESC lignin, i.e., SESC lignin does not insert into MMT interlayers.<sup>S1</sup> Thus, Epocros® inserts between the MMT platelets. The XRD patterns were collected using a Rigaku Smart Lab X-ray diffractometer using Cu K $\alpha$  radiation, a Cu K $\beta$  filter, a 2.5° Soller slit, and a nonreflecting rotation stage. The collected count range was 2–20°  $2\theta$  in 0.02°  $2\theta$  increments.



**Fig. S2** Typical crosslinking reaction between SESC lignin and Epocros®. Here, the hydroxyl groups in lignin and the oxazoline groups in Epocros® form covalent bonds.<sup>S2</sup> This crosslinking reaction between SESC lignin and Epocros® in their water dispersion causes the gelation of the SESC lignin and Epocros® mixture (SESC lignin:Epocros® = 1:1 w/w%), as shown in right photos.



**Fig. S3** Typical UV-vis spectrum of clay-lignin films consisting of ST and SESC lignin (ST:SESC lignin = 80:20 w/w%)



**Fig. S4.** XRD pattern of clay-lignin films consisting of ST and SESC lignin with PVA (upper, ST:PVA:SESC lignin = 76:19:5 w/w%) and neat ST (lower). The lowest  $2\theta$  peak (the basal (001) reflection of the ST) shifted to a smaller  $2\theta$  angle by the addition of PVA. As shown in Fig. S1, the  $2\theta$  peak was unaffected by the addition of SESC lignin. Thus, the PVA intercalates into ST interlayer.

#### REFERENCES

- S1 K. Shikinaka, M. Nakamura, R. R. Navarro and Y. Otsuka, *Green Chem.*, 2019, **21**, 498.  
 S2 K. Takahashi, R. Ishii, T. Nakamura, A. Suzuki, T. Ebina, M. Yoshida, M. Kubota, T. T. Nge and T. Yamada, *Adv. Mater.* 2017, **29**, 1606512.