Supporting Information

Isotropic Paper Directly from Anisotropic Wood: Top-down Green Transparent Substrate Toward Biodegradable Electronics

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Figure S1. The wood slices with uniform thicknesses and flat surfaces. Basswood is used for photo and the cutting direction is perpendicular to the wood growth direction. The thicknesses of the slices vary from about 400μm to 1mm.

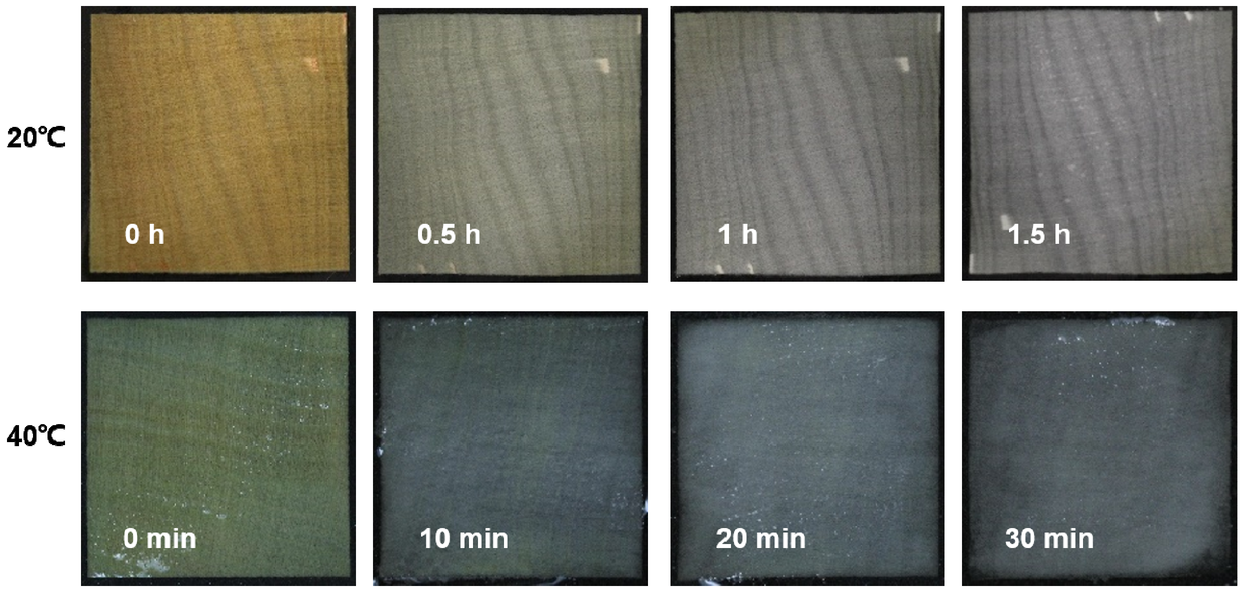

Figure S2. Color changes during the delignification process when using NaClO as the delignification chemical (about 10 wt. % in concentration). The wood color changes from yellow to white, gradually with increasing delignification time. At a delignification temperature of 20 ^{o}C, the wood loses its yellow color after about 1.5 h. However, the same process only takes about 30 minutes at a delignification temperature of 40 ^{o}C. In our fabrication process, delignification is carried out at about 20 ^{o}C and the delignification time is about 3 hours.

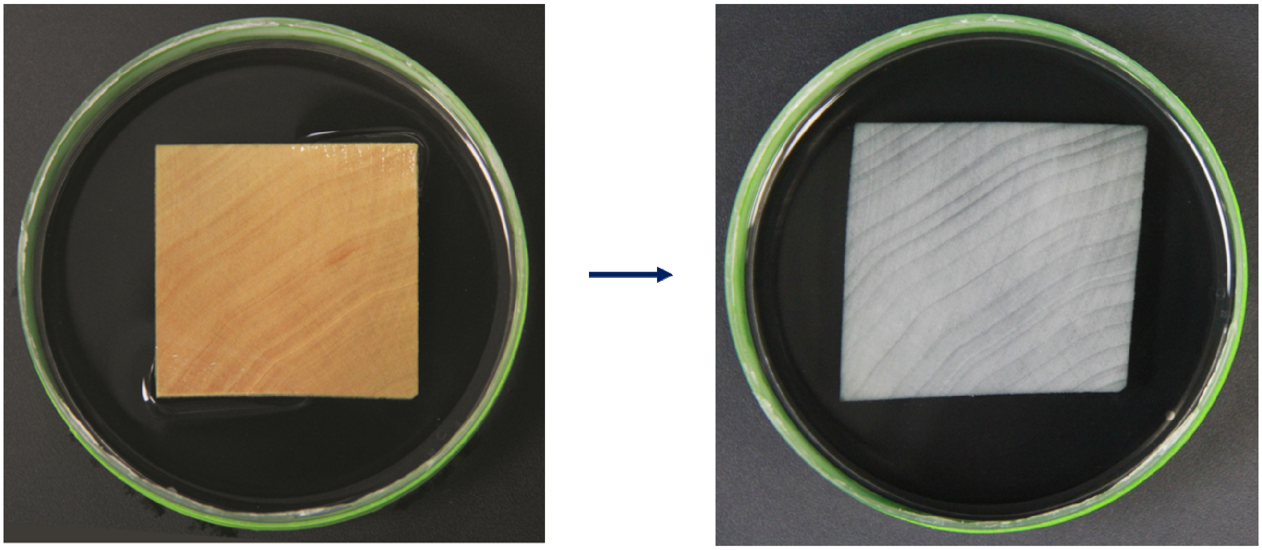

Figure S3. The delignification setup and the colors of wood slice before and after delignification.

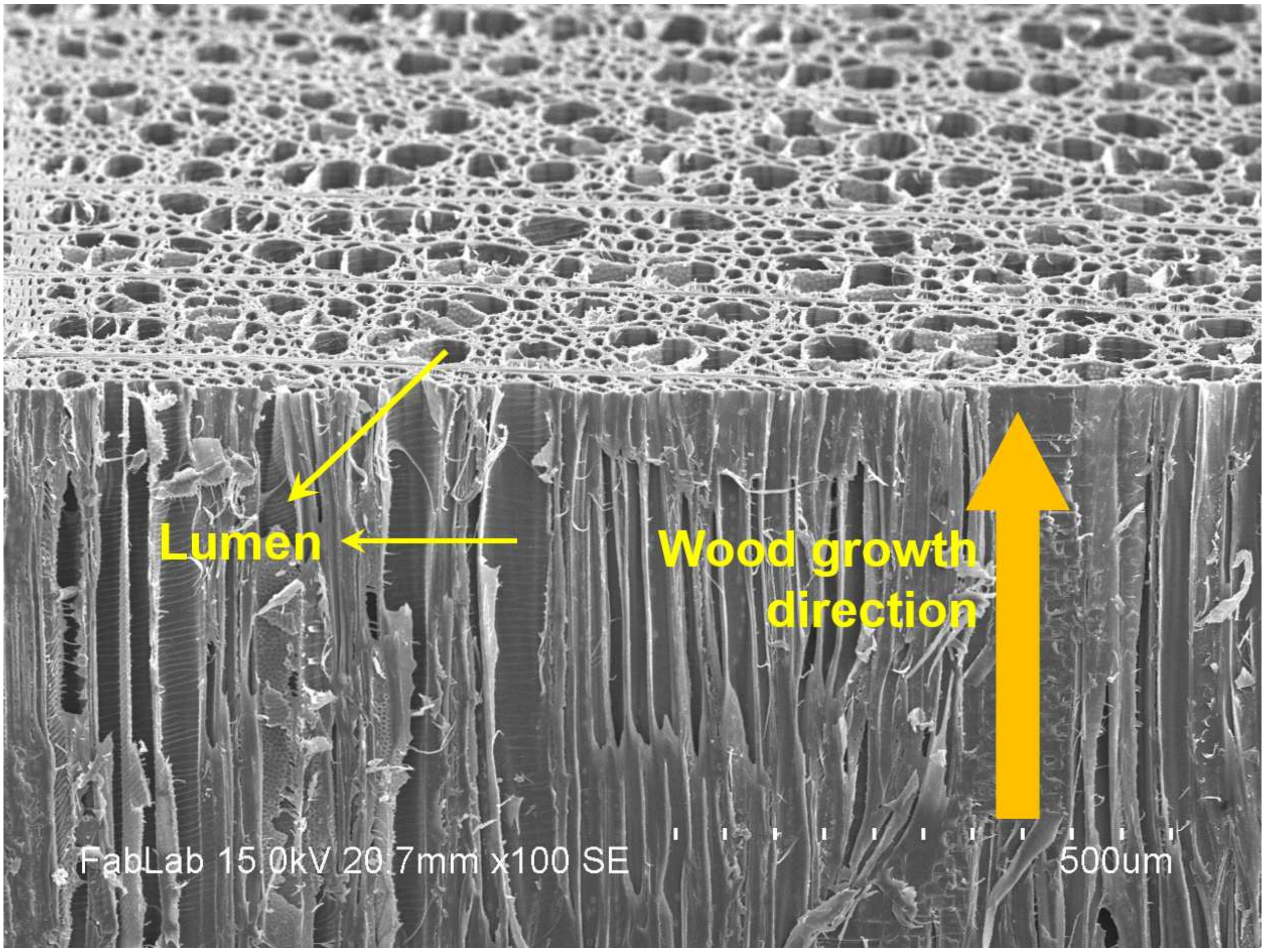

Figure S4. The wood microstructure, showing the presence of lumen oriented along the wood growth direction. The cell wall is composed of cellulose micro- and nano-fibers.

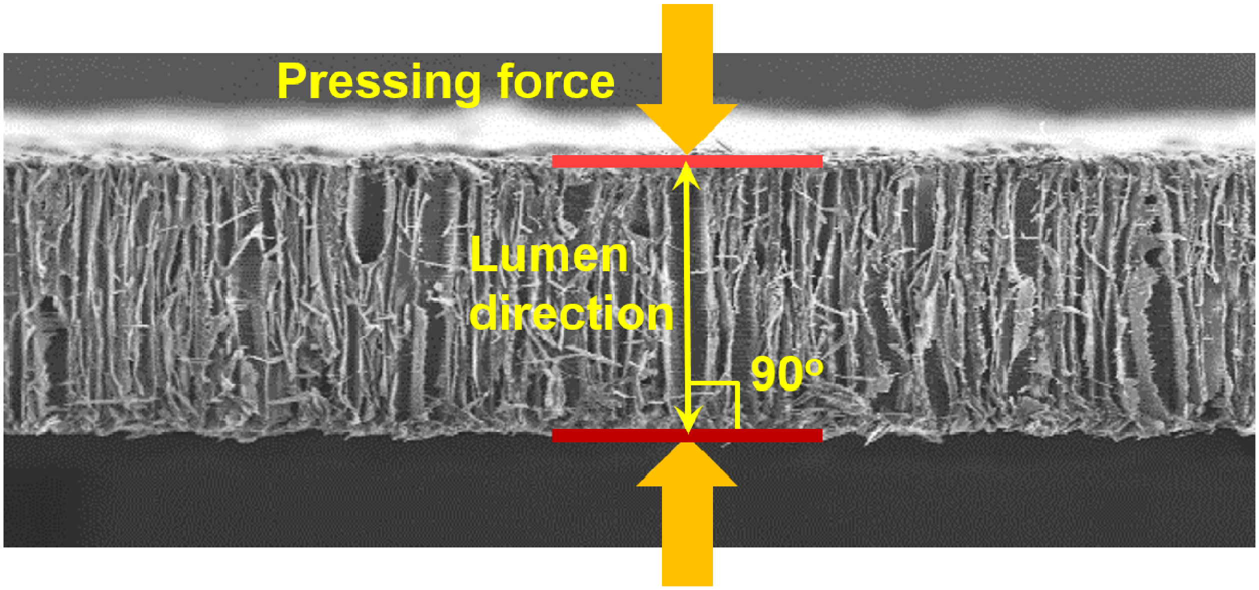

Figure S5. The mechanism by which anisotropic wood can be used to fabricate isotropic paper. The direction of the pressing force is along the lumen direction. In wood, most fibers are in the S2 layer of the cell wall. They are aligned along the lumen axis direction with an angle deviation known as the micro-fibril angle. Thus, during pressing, the lumen collapses in random directions, which leads to the formation of isotropic, transparent paper.

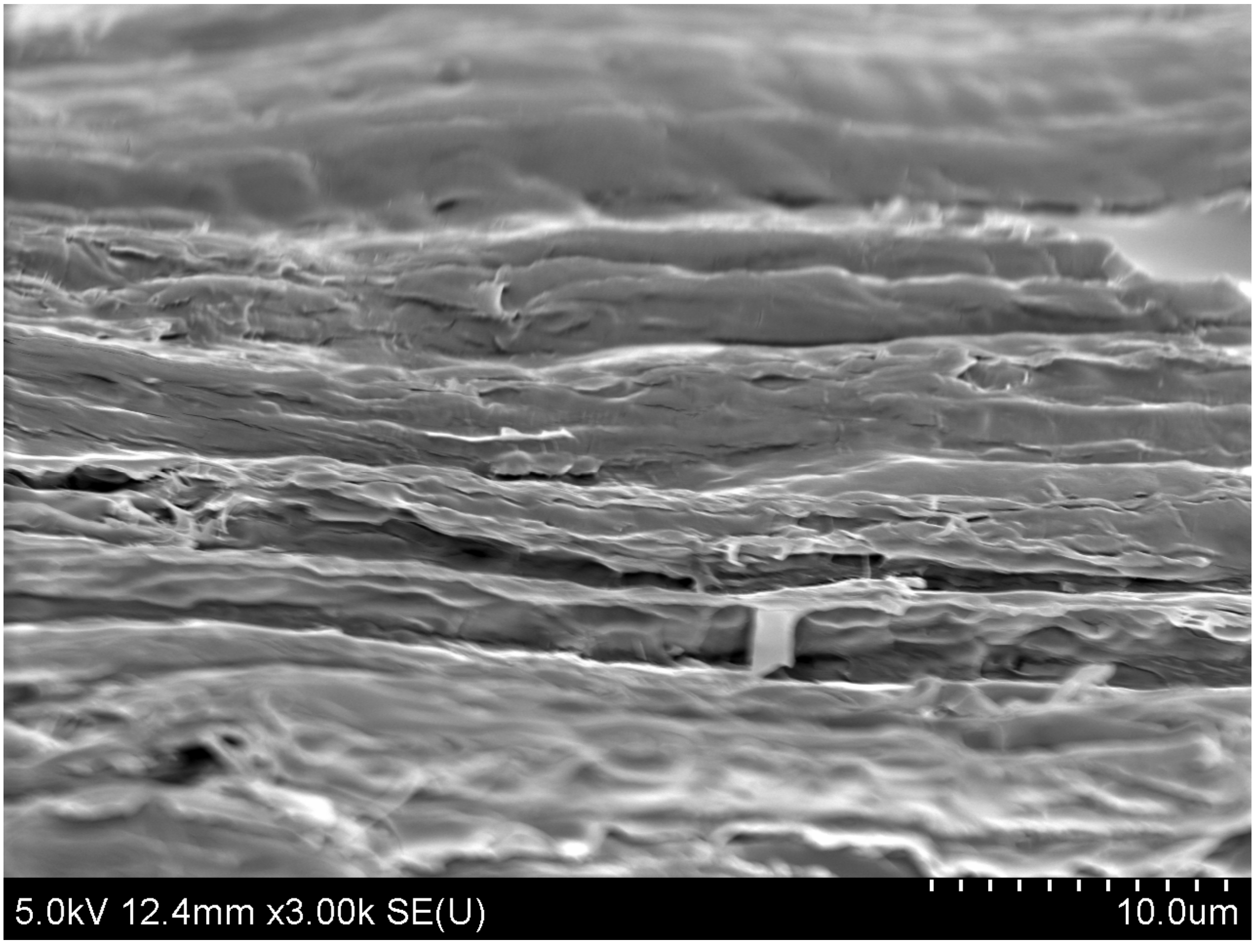

Figure S6. SEM image of the details of the isotropic, transparent paper. The fiber configuration cannot be distinguished. The isotropic, transparent paper has a dense, layered structure that will greatly lower the light diffraction compared to in the wood.

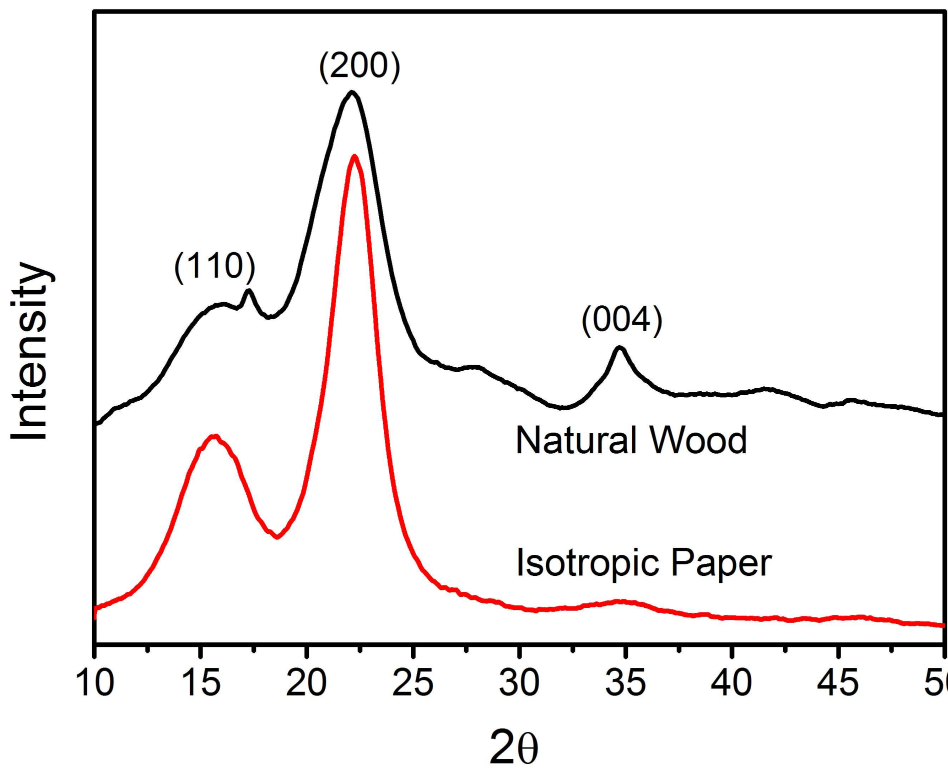

Figure S7. XRD of the wood and the isotropic, transparent paper. Their compositions are all cellulose.

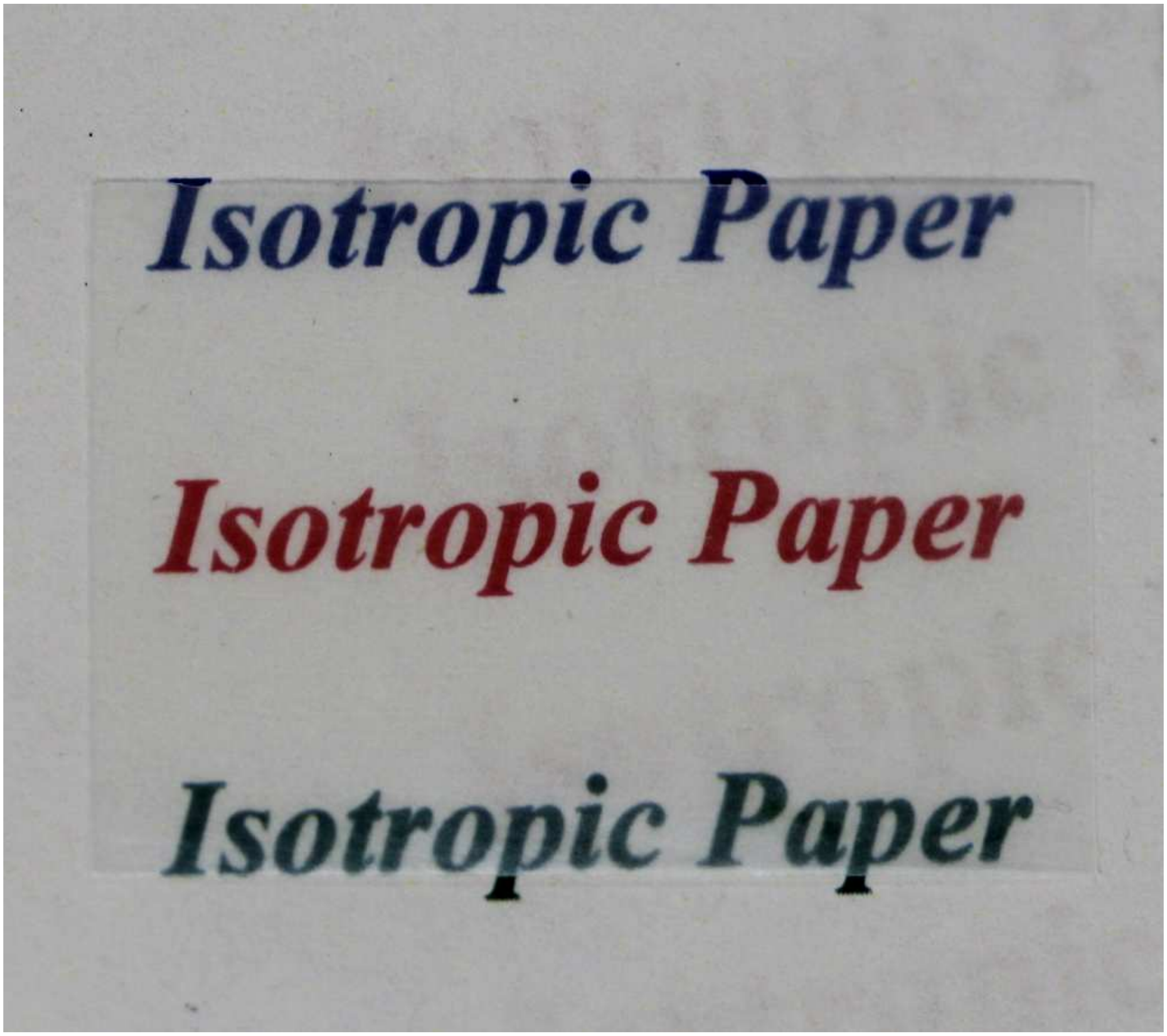

Figure S8. Optical image of the transparent paper. The characters beneath the paper can be clearly seen, indicating the high transparency of the paper.

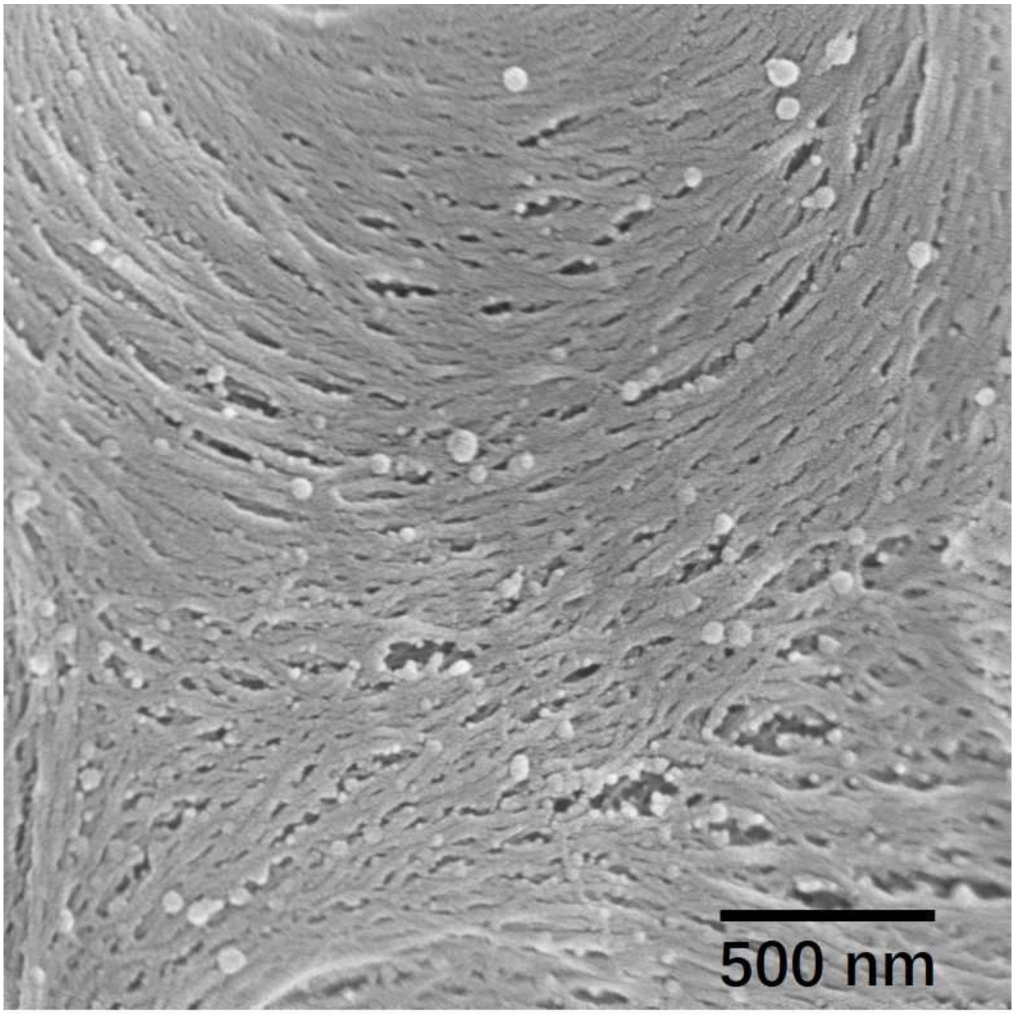

Figure S9. SEM image of the inner surface of wood. It shows the anisotropic distribution of cellulose nanofibers in wood.

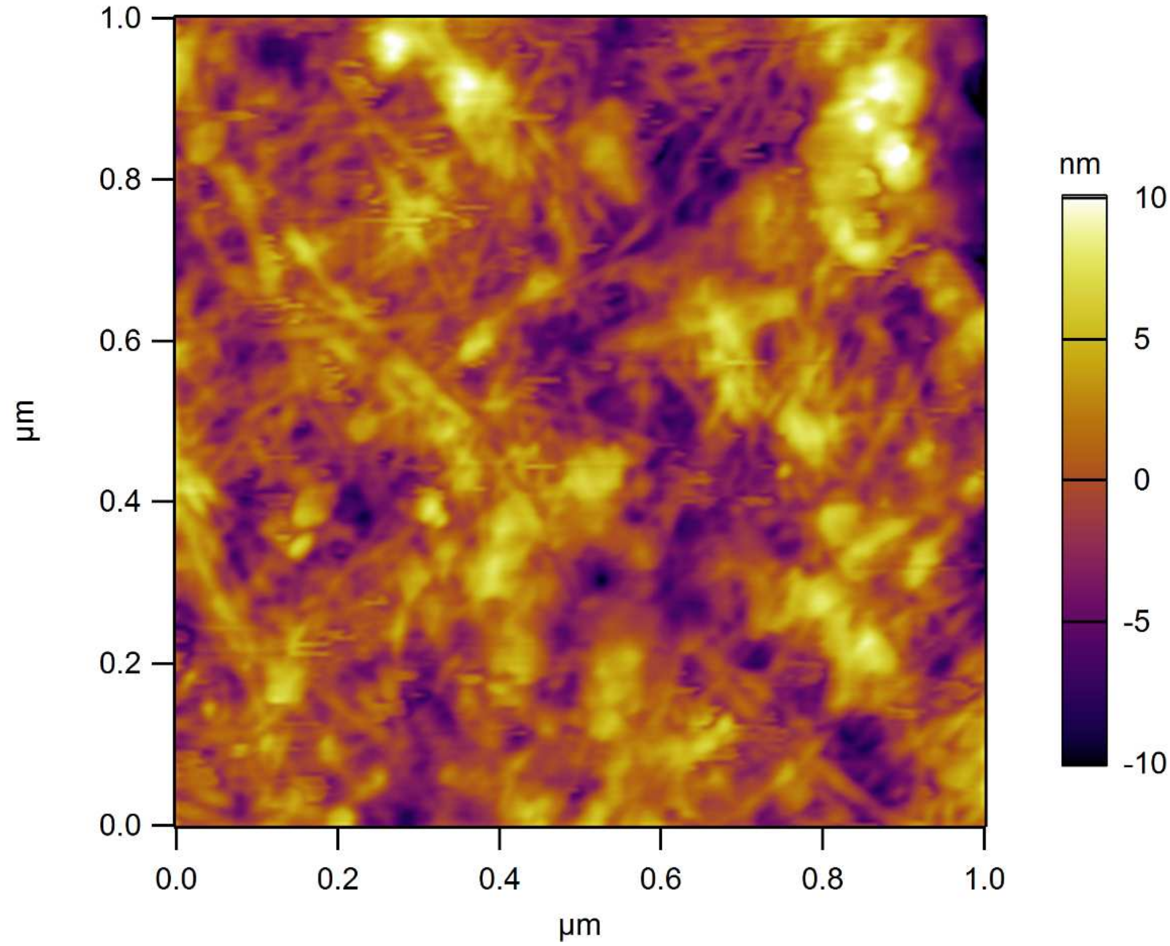

Figure S10. AFM image of the surface of the transparent paper. The nanofibers are randomly packed and show isotropic property.

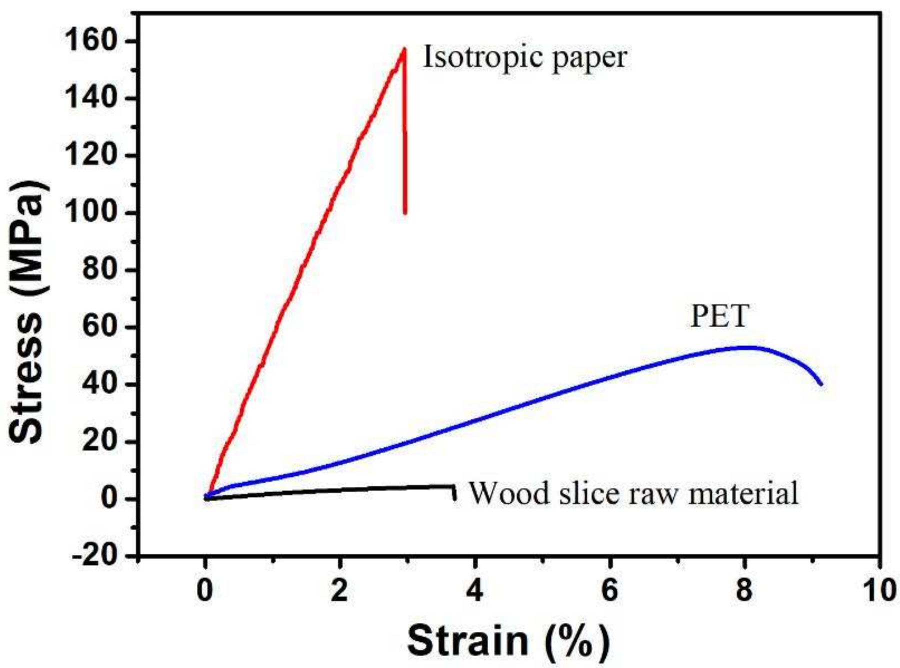

Figure S11. Typical experimental stress-strain curves for isotropic paper, PET and basswood slice perpendicular to the growth direction. The isotropic paper is strong with a tensile strength of about 150 Mpa.

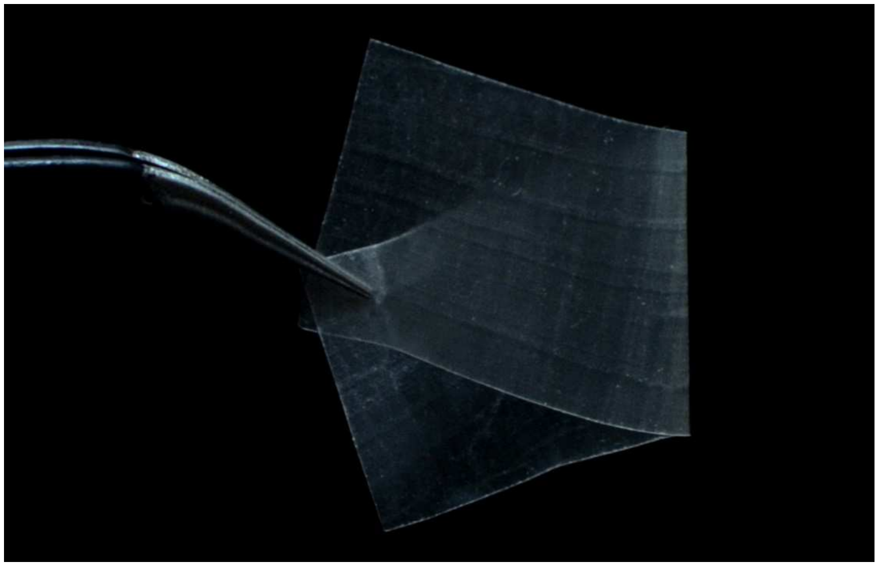

Figure S12. The isotropic paper is flexible and can be potentially used as substrate for biodegradable and flexible optical and electronic devices.

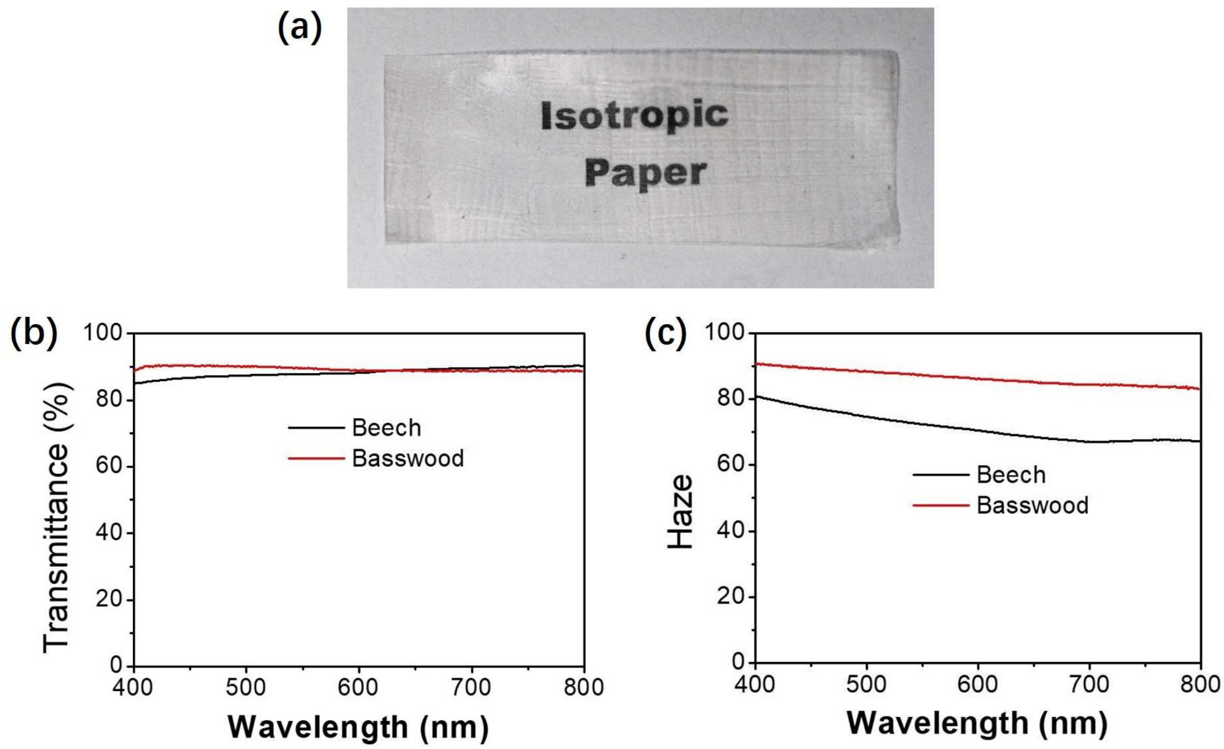

Figure S13. The comparison of papers made from beech wood and basswood. (a) Isotropic paper made from beech wood. (b) and (c) shows their transmittance and haze spectra.

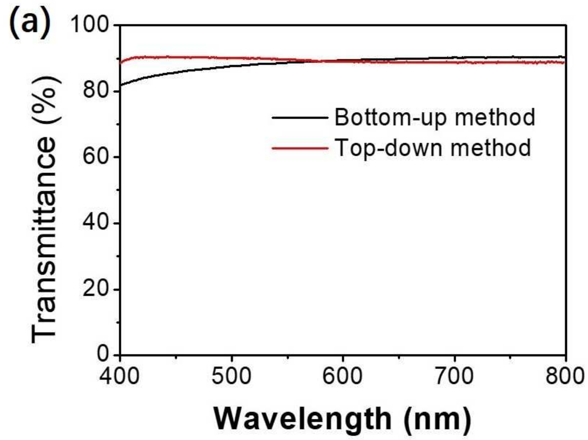

Figure S14. The transmittance (a) and haze (b) of the transparent paper made by the top-down method and bottom-up method.