

Supplementary Material

Supplementary Videos



July_movie.avi



June_movie.avi



August_movie.avi

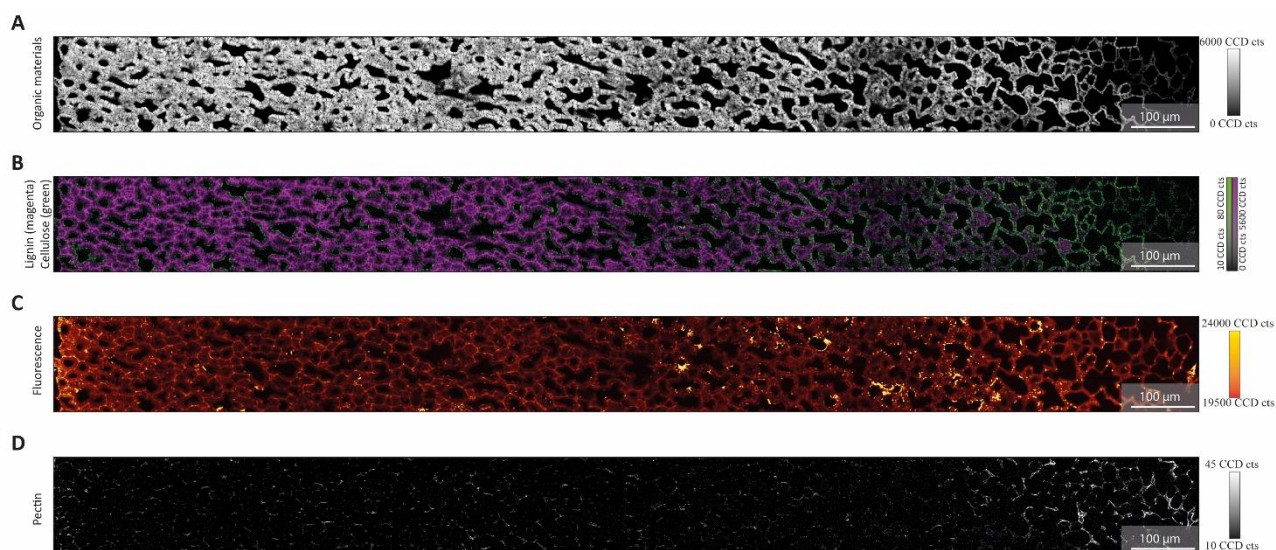


October_movie.avi

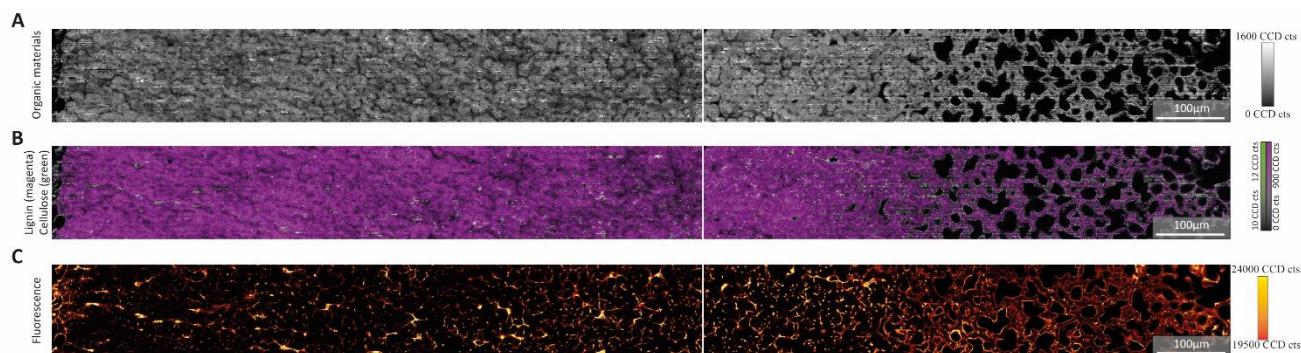


September_movie.avi

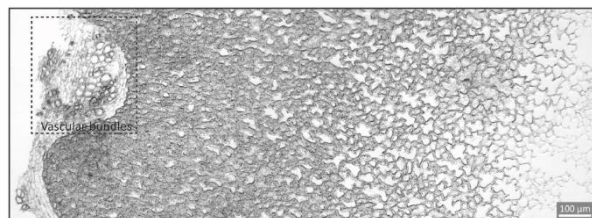
Supplementary Figures



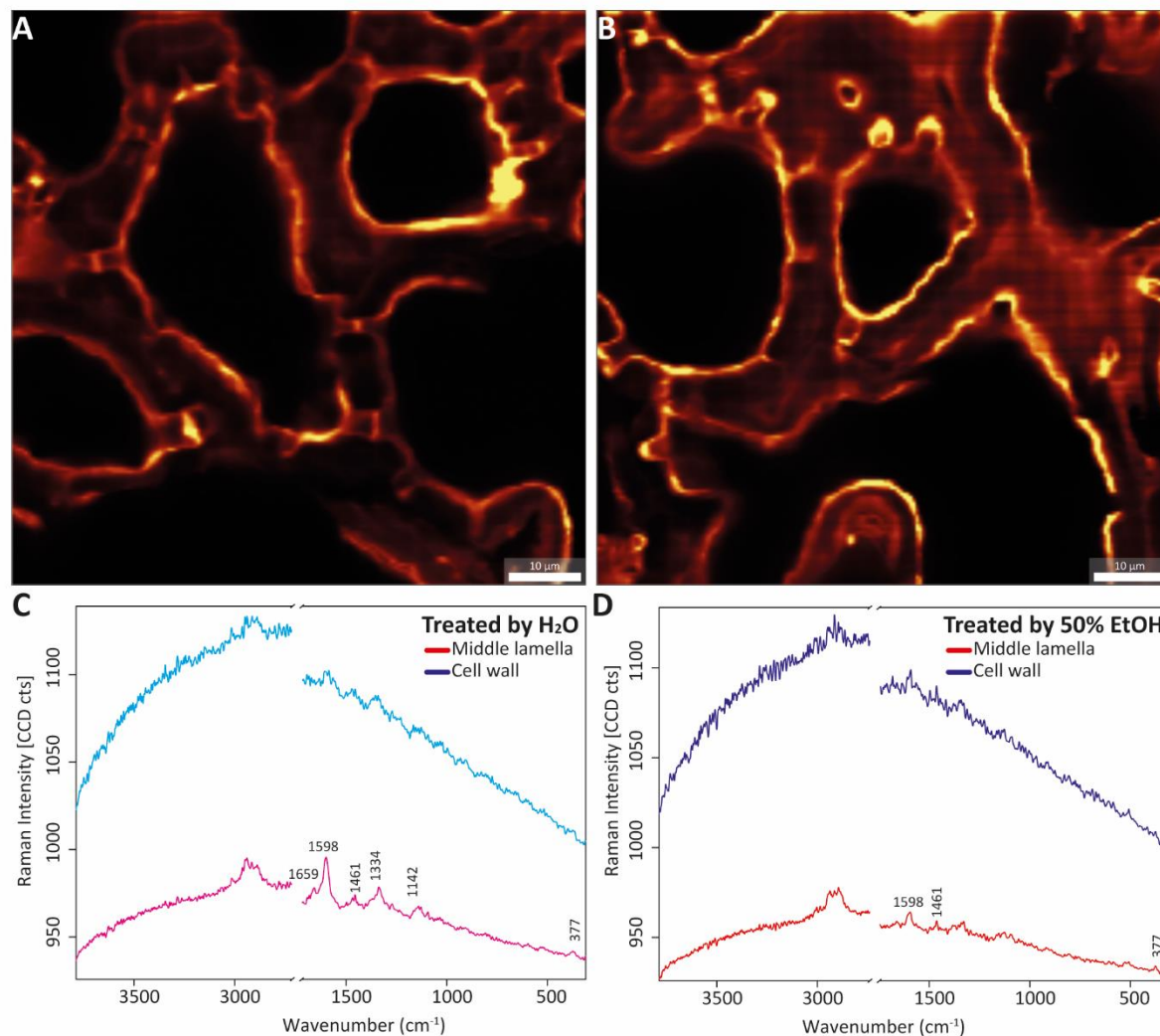
Supplementary Figure 1. Representative Raman images of the whole walnut shell section of July. (A-F) Raman images ($1800 \mu\text{m} \times 150 \mu\text{m}$) were calculated by integrating over (A) CH-stretching region $2745\text{--}3054 \text{ cm}^{-1}$. (B) Lignin around the region $1535\text{--}1704 \text{ cm}^{-1}$ (in magenta) overlaid with cellulose bands ($1358\text{--}1401 \text{ cm}^{-1}$, in green). (C) Fluorescence region (D) Pectin around the region ($839 \text{ cm}^{-1}\text{--}872 \text{ cm}^{-1}$).



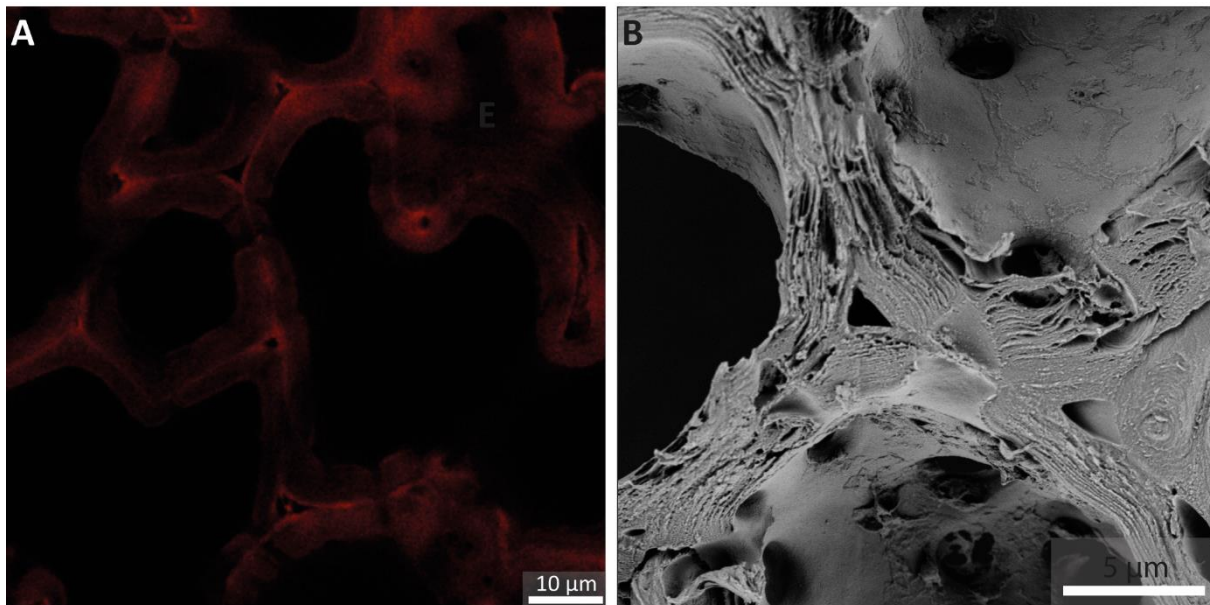
Supplementary Figure 2. Representative Raman images of the whole walnut shell section of October. (A-E) Raman images ($1800 \mu\text{m} \times 150 \mu\text{m}$) were calculated by integrating over (A) CH-stretching region $2745\text{--}3054 \text{ cm}^{-1}$. (B) Lignin around the region $1535\text{--}1704 \text{ cm}^{-1}$ (in magenta) overlaid with cellulose bands ($1358\text{--}1401 \text{ cm}^{-1}$, in green). (C) Fluorescence region.



Supplementary Figure 3. Bright field photomicrograph of walnut shell section of July, showing the vascular bundles in the adjacent green husk.



Supplementary Figure 4. Comparison of Raman images of walnut shell inner part from October treated by H₂O and 50% Ethanol, respectively. (A and B) Raman images based on integrating over fluorescence region, corresponding to treatment of H₂O and 50% EtOH at 70 °C for 48h, respectively. (C and D) Average spectra extracted from the cell wall and compound middle lamella area, respectively.



Supplementary Figure 5. Confocal fluorescence image and Scanning electron microscope (SEM) image of walnut shell inner part from October. (A) Confocal fluorescence image of lignin autofluorescence. (B) SEM image of inner part of walnut shell with substance stick to the cell wall.