Supporting Information

Fast water absorption material inspired by cactus root.

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Measuring water absorption ability of cactus root

To compare the water absorption abilities of the roots of cactus and general plants, we used six different species of well-grown cacti, namely, *Gymnocalycium mihanovichii, Corpuscularia lehmannii, Mammillaria backebergiana, Sedum corynephyllum, Faucaria tigrina,* and *Cotyledon. pendens*. *Murraya paniculata, Cupressus macrocarpa, Mandevilla Splendens, Neofinetia falcate,* and *Chrysanthemum morifolium* were used as controls. The water absorption ratio of plant roots is defined as $R_a = \frac{r_f - r_i}{r_i}$, where r_i is the initial mass of a root immediately after being taken out from dried soil, and r_f is the final mass of the root after dipping in water for 1 min. To investigate the role of rhizosheath, we measured the water absorption ratio R_a of the *M. backebergiana* root after clearly removing the rhizosheath around the main root.

Visualization of morphological features of cactus roots

The morphological features of the sliced cactus roots were observed with a digital camera (Nikon D700, Tokyo, Japan) attached to an optical microscope (Nikon Eclipse 80i, Tokyo, Japan). The detailed morphological images of the freeze-dried roots and fabricated CRIM models were captured with a field emission scanning electron microscope (FE-SEM, JEOL JSM-7401F, JEOL).

X-ray micro-imaging

X-ray imaging experiments were conducted at the 6C bio-medical imaging beamline of Pohang Light Source II. Water absorption in the cactus roots was quantitatively visualized through an X-ray imaging technique (Figure 1c). Iopromide solution was supplied to the test root samples for the enhancement of the image contrast of the liquid used. The 3D morphological structures of the test samples were observed through X-ray micro-computed

tomography (CT). A 10× objective lens was attached in front of a sCMOS camera (Andor Zyla, Belfast, UK). The spatial resolution was approximately 0.65 μm/pixel for the 1.7 mm × 1.4 mm field of view. The distance from the test sample to the camera was fixed at 50 mm. An experimental model was attached to the sample holder, which was then rotated from 0° to 180° at 1° intervals. The 3D tomographic structures were numerically reconstructed and rendered by using the commercial versions of Octopus (inCT) and Amira® (Visualization Sciences Group), respectively.

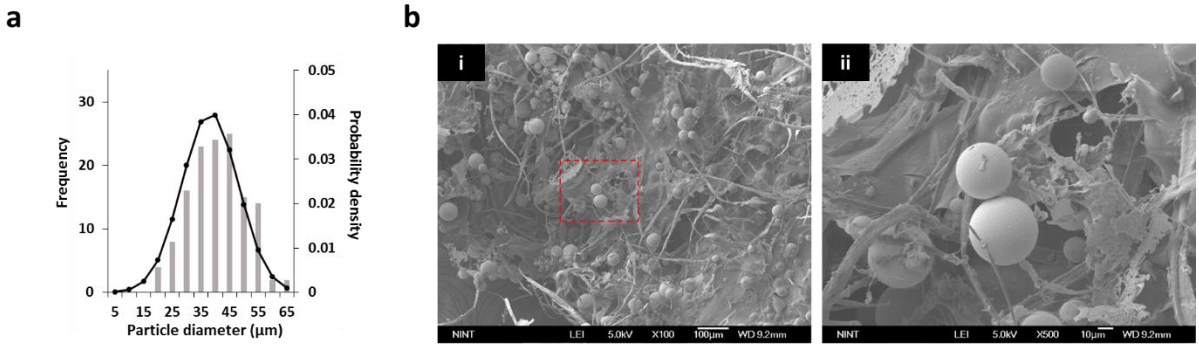

Figure S1. (a) Normal distributions of microparticle diameter. (b) SEM images of the CCM material which clearly show the morphology of microparticles.

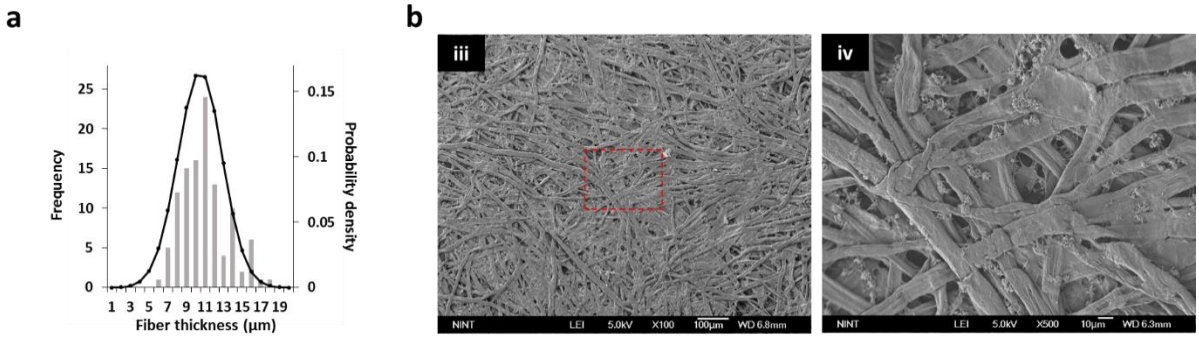

Figure S2. (a) Normal distributions of cellulose fiber thickness of the CRIM model. (b) SEM images of the cellulose paper before grounded into fibers.

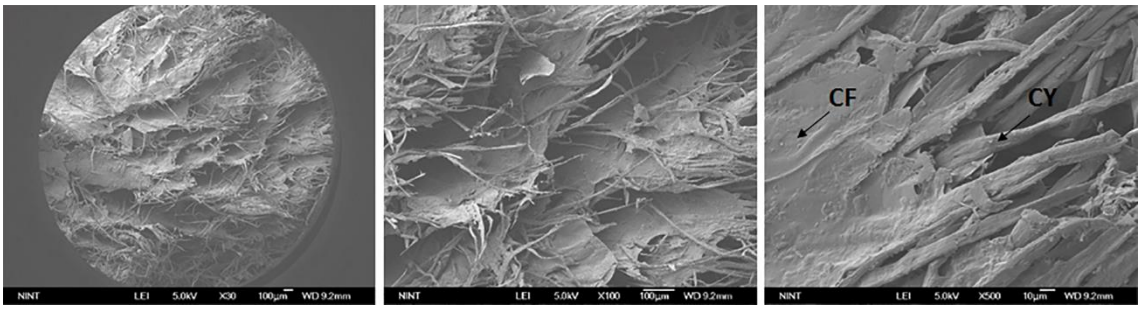

Figure S3. SEM images of the CC model. Cellulose fibers were clotted with cryogel and the layered structure was formed.

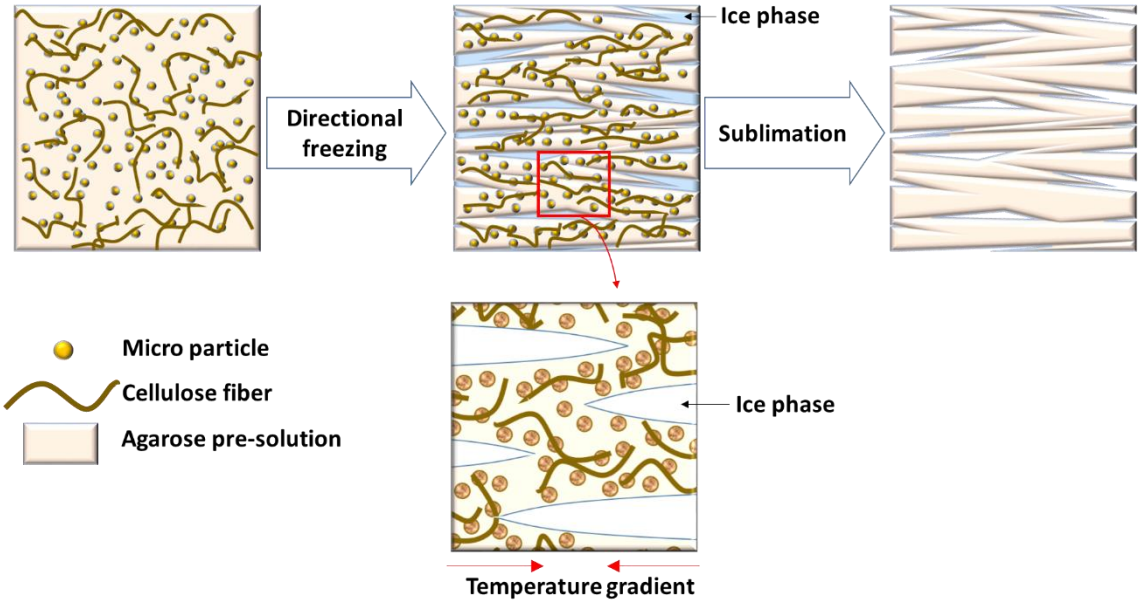

Figure S4. Composites obtained by the directional freeze casting posessed a highly-aligned cellulose fibers along freezing direction.