Structure and Electronic Properties of Carbonized Nanocellulose and Nanochitin Papers

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Nanocellulose and nanochitin, which are bionanofibers obtained from forest and sea, respectively, have recently gained great interest because of their attractive properties such as excellent mechanical strength, high surface area, abundance, renewability and biodegradability. These bionanofibers have been frequently composited with petroleum- or metal-based nanomaterials to develop new types of functional nanocomposites. However, the use of such non-renewable resources makes it difficult to achieve truly green sustainable development. From this point of view, there is a growing importance to functionalize the bionanofibers themselves for advanced applications. Here we report the preparation and electronic properties of the carbonized nanocellulose and nanochitin as new types of carbon nanofiber materials.

Nanocellulose and nanochitin were first fabricated into papers by vacuum filtration of their aqueous dispersions, solution exchange by *t*-butanol, and freeze-drying. The as-prepared papers were then carbonized at different temperatures (300, 500, 700, 900, 1100 °C) in N_2 for 1 h. As shown in Fig. 1 (left), the nanofiber structure of the carbonized nanochitin paper was maintained even at high carbonization temperature (1100 °C), while that of the carbonized nanocellulose paper was destroyed. The carbonized nanochitin paper showed high yield and volume retention (16% and 25% at 1100 °C, respectively) than the carbonized nanocellulose paper (8% and 12%), indicating that nanochitin is structurally more stable against high temperature treatment than nanocellulose. The surface resistance values of both papers were changed ranging from 10^{15} to 10^{0} Ω/□, depending on their carbonization temperatures (Fig. 1, right); the nanocellulose and nanochitin papers could be converted from electrical insulator to semiconductor and quasi-conductor by carbonization. Our finding will open new doors for all bionanofiber-based green electronics. Of special note is that the carbonized nanochitin paper exhibited higher electrical conductivity than the carbonized nanocellulose paper. These results suggested that nanochitin has better performances than nanocellulose in morphology and conductivity after carbonization. The mechanism of different morphologies and electrical properties between them will be further investigated.

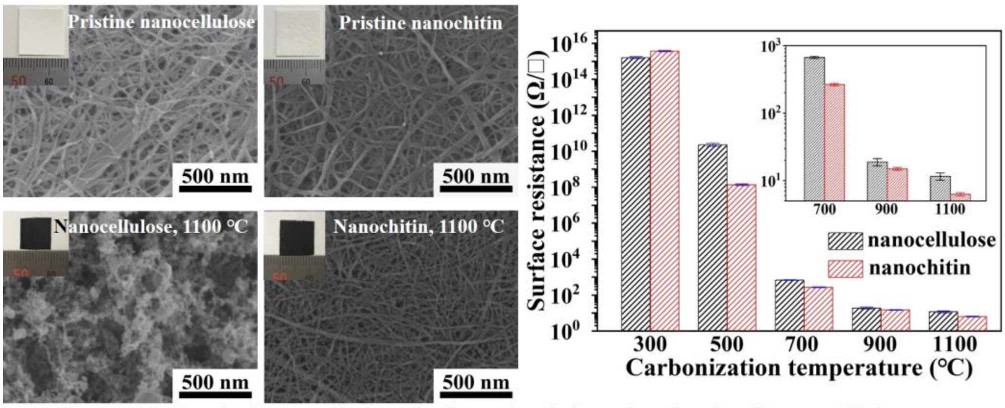

Figure 1. Morphology and electrical conductivity of carbonized nanocellulose and nanochitin paper.

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