

Untraditional Usage of Forestry and Agriculture Products as Energy Sources and Engineering Materials

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Historically, agriculture and forestry were the primary source for energy (heat) and engineering materials for mankind. In modern society, especially due to the wide usage of fossil fuels, the importance of forestry and agriculture products as energy sources and engineering materials was decreasing. However, their importance has been increasing due to the concern of climatic change. These increase can be represented by the increasing usage of liquid fuel derived from biomass and the increasing interest in the development of engineering materials from renewable materials. Current development of renewable engineering materials from biomass is focused on structural materials.

In this talk, we report our developments of forestry and agriculture products as energy sources and engineering materials. As energy sources, firstly we report the cellulose nanocrystals (CNCs) can be directly used as fuel for internal-combustion engines. Compared to current practice, this approach does not need to convert the biomass into liquid fuel and can use almost all kinds of biomass. Secondly, we report that the electrical energy can be directly harvested from agriculture products such as fresh produce.

Regarding the development of engineering materials, we report the development of high-performance functional materials from forestry and agriculture products. Firstly, CNCs from biomass are developed as renewable piezoelectric materials – a new type of engineering materials. From the application point of view, energy in electrical form is the most important form for current applications. Due to the high piezoelectric response and renewability of CNC, CNC-based piezoelectric materials are expected to play more and more role in the future development of energy harvest devices – harvesting mechanical energy (i.e., wide and mechanical vibration). It has to be mentioned that the piezoelectric materials can not only used to harvest energy, but also to build sensors and actuators that are the foundation for all the high-tech devices/systems and future engineering devices such as driverless vehicle, unmanned airplane and various robots. Secondly, we report that the CNC can significantly enhance the performance of artificial muscle – a type of newly developed smart materials.

Keywords: biomass, fresh produce, cellulose nanocrystal, energy generation, engineering material