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Nanocellulose, The Origin of Natural Reinforcement in Advanced Biocomposites

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The study on nanocellulose was early reported in 1956 by Battista *et al*., for the term of level-off degree of polymerization of cellulose which nowadays the crystal is maintained with high aspect ratio (length/diameter) as named as cellulose nanocrystal and further, in 1983 by Turbak *et al*., for the term of microfibrillated cellulose which has gel-like structure and thixotropic viscosity properties, afterwards, the extraction study of nanocellulose has gaining sky rocketly in the number of publications, yet it is not commercially available in the market readily in the general bioproducts. Cellulose is the most abundant and ubiquitous linier biopolymer on earth and is found in the cell walls of plants as the origin, where it provides structural support for plants consist of glucose monomer with 1-4-β glycosidic linkage. While nanocellulose is a type of cellulose material that has been broken down into nanoscale dimensions which contain aggregation of cellulose biopolymer due to inter- and intra-molecular hydrogen bonding within cellulose. Those nanoscales provide zero-defect, nir-dislocation, which caused high modulus strength and high tensile strength material, up to 150 GPa and 2 GPa, respectively. The remarkable properties of cellulose provide the wood as a strong, tough and smart living organism. Therefore, with nanotechnology, many scholars have seeking knowledge to mimic the biocomposite of wood to make lightweight, strong, tough, and functionalized advanced materials. The behavior of nanocellulose as reinforcing agents has been elaborated for their high surface area, surface charge for better dispersion, surface functionality, dimension and morphology, thermal expansion, crystallinity, and amphiphilicity. Beside nanocellulose properties, the key-technology to develop advanced bionanocomposite is the ability to handle the interface and interphase between reinforcing agent and its matrix and the choice of matrices is also important. The hierarchical structure of cellulose in wood could be the inspiration to modify the interaction of nanocellulose within composite such as hybrid, tertiary

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bionanocomposite, honey-comb designed composite, or interpenetrated polymer networks composite.

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Nanang Masruchin, Ph.D is a research professor at Research Center for Biomass and Bioproducts, the National Research and Innovation Agency of Indonesia (BRIN). He has been working in nanocellulose and its composite since 2008. He received his doctoral degree from Department of Wood and Paper Science, Kyungpook National University, Republic of Korea with entitled dissertation is "Cellulose nanofibrils-based functional hydrogels for drug release application". Nowadays, he and his teamworks at Research Groups for Nanocellulose try to up-scale the production of nanocellulose into pilot plant and establishing commercially industry in Indonesia. He manages and joins collaboration nationally and globally with universities researchers through Research Collaboration Center for Biomass and Biorefinary between BRIN and Universitas Padjadjaran and Research Collaboration Center for Nanocellulose between BRIN and Universitas Andalas. His academic profile can be followed online via google scholar, SCOPUS, ORCID, Web of Science. He is interesting for enhancing collaborations and can be emailed through nana021@brin.go.id