

## **Structural characterization of carbon materials derived from chestnut biomass**

M. Jamshaid Shabbir<sup>1</sup>, B. Liszka<sup>2</sup>, M. Szubka<sup>1</sup> and K. Jurkiewicz<sup>1</sup>

<sup>1</sup>*Institute of Physics, Faculty of Science and Technology, University of Silesia in Katowice, Chorzów, Poland*

<sup>2</sup>*Faculty of Natural Sciences, University of Silesia in Katowice, Sosnowiec, Poland*

\*e-mail: [mjamshaid.shabbir@us.edu.pl](mailto:mjamshaid.shabbir@us.edu.pl)

One of the greatest challenges of modern science and industry is to reduce the carbon footprint and produce environmentally friendly materials. In the area of carbon materials, such goals can be achieved using cheap and abundant biomass-derived carbon precursors as well as catalytic-graphitization processes, which may reduce the temperature of the heat treatment required to obtain specific atomic structures. In this contribution, the structural characterization of the chestnut-derived carbon materials produced via standard carbonization at various temperatures (950, 1400, 1700°C) will be presented. Moreover, the heat treatment of the chestnut-derived materials in the presence of Si and CaCO<sub>3</sub> particles was performed in order to evaluate their possible catalytic graphitization effect on the structure of the carbon matrix as well as the porosity. Si has been a well-known effective catalyst of graphitization for decades, while Ca is nowadays more often considered as an alternative due to its abundance, low cost, and that the catalytic effect of Ca is observed at relatively low temperatures, leading to enhancement of the degree of graphite-like order in carbon material. Moreover, Si and Ca elements may exist naturally in chestnut fruits. As a reference, cellulose-derived carbon (cellulose is one of the main components of chestnuts) was heat-treated in similar conditions and using the same catalysts.

The results of X-ray diffraction and Raman spectroscopy structural studies will be presented, which were used to characterize the transformation of the atomic-scale structure of the studied cellulose-based and chestnut-based carbon materials heat-treated at various temperatures under Ar gas. Moreover, by supporting energy-dispersive X-ray spectroscopy measurements in a scanning electron microscope, it was possible to characterize their elemental and phase composition. The effect of the catalysts on the structure is evaluated. Moreover, the aim of these studies is to determine the impact of catalytic graphitization on the porosity of these materials. Since their porosity is mainly closed, it cannot be probed by gas adsorption methods. Therefore, the results of preliminary synchrotron small-angle X-ray scattering studies will be presented to reveal the changes in the porous structure.

The results of the presented studies may be significant when considering such carbon materials as anode active materials of sodium-/potassium-/lithium-ion cells where both atomic-scale structure of stacked graphene layers, as well as porosity, play a huge role.