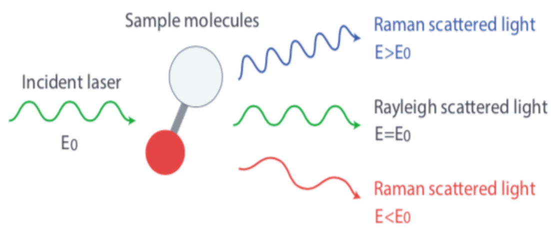
Rima Zuriah Amdani

Molecular Fingerprint of Biochar by Raman Spectroscopy

We all aware the usage of non-reusable materials can cause environmental problems which lead to the use of renewable resources into many applications including for the industrial sector. Regarding that matters, porous carbon materials that come from biomass, such as animals, plants, or organic waste residual gained attention as feedstock. Porous carbon is formed by heating the carbon-based material (for example: wood). People have used that material in soil fertility and water treatments for decades. Nowadays, it is also used for energy storage in electrical devices such as batteries and supercapacitors. Meanwhile, the selection and treatment of the material for a specific function depends on its characteristics. So, it is important to characterize the material structure to get adequate information, for example a structure with large porosity will increase the energy storage capability which is good for a raw material to produce supercapacitors.



https://www.nanophoton.net/raman-spectroscopy/lessons/lesson-1

What kind of measurement technique is suitable for the investigation? Electron microscopy techniques are capable to measure materials with fine detail but require extensive samples preparation. Raman spectroscopy is well known as an optical technique, which is sensitive to measure the structure of porous carbon material. The Raman spectroscopy technique is based on the interaction of light (for example: laser source) with a molecule in the material that can cause scattered light with a frequency shift. This shifting in frequency represents the molecule fingerprint. So, the structural features (for instance: the crystalline surface area) of the material can be examined. Moreover, this method requires less sample preparation (such as without grinding and coloring), and analysis time which is very convenient for performing the measurement activities.

What we have done in this study? Biomass samples have been heated at various temperatures, and then measured with the Raman method to examine the structural properties through the spectral shapes of the spectra. The results show that the heating treatment can change the carbon structures. The increasing temperature can raise the aromaticity and surface area of the crystalline carbon structure. The aromaticity represents the proportion of the total C phases (amorphous and crystalline) within the samples. Higher aromaticity means that the carbon structure of material become more condensed. The crystalline surface area is indicated by the value of the crystalline length (L_a) of the material, which was found to be around 9-10 Å. As complementary, the data from Raman measurements were also compared with elemental analysis results to show the amount of carbon content in the samples. As expected, the results from elemental analysis show that the higher temperature will produce higher carbon proportion in the samples. In conclusion, both methods give similar trends for evaluating the structure of the samples. The heating treatment affects the material structure, so the material properties can be enhanced by adjusting the heating temperature.

Supervisors: **Christian Brackmann, Frederik Osler**
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Combustion Physics, Lund University