doi:10.1017/S1431927622003105
Microsc. Microanal. 28 (Suppl 1), 2022

Elemental Analysis of Spent Coffee Ground Derived Biochar Using SEM/EDS

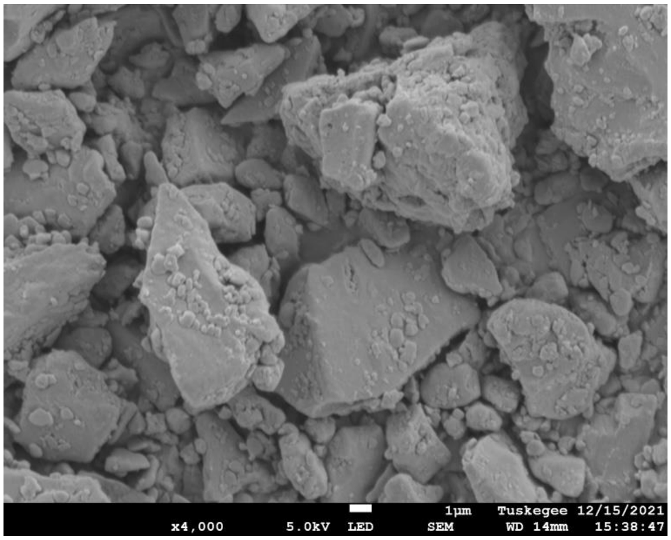
Ahmed Alhelal[1], Shaik Jeelani[1] and Vijaya Rangari[1*]

[1.]Department of Materials Science and Engineering, Tuskegee University,Tuskegee, USA.
* Corresponding author: vrangari@tuskegee.edu

With the depletion of petroleum supplies, global warming, and environmental degradation, researchers have turned their attention to sustainable material synthesis and surface modification [1-2]. Renewable, environmentally benign, and abundant biomass resources are being explored as a possible starting material for carbon synthesis. Biochar is the carbon produced by the controlled thermal breakdown of biomass [3]. The biochar thus produced can be utilized for applications like soil remediation, composites, energy storage, tissue engineering etc. [4-7]. The most essential qualities that define biochar's use and performance are its structural morphology and composition. However, these properties are dependent on type of biomass feedstock, pyrolysis parameters and post modification methods. Having a thorough understanding of the physical and chemical characteristics of biochar is essential to identify its potential application. Hence selecting the most appropriate precursor biomass for biochar synthesis is the most cost-effective way to synthesize carbon based materials with desired constituent materials. Spent coffee grounds (SCG) are among the most common biomass. It is estimated that around 9.3 billion kg SCG is generated every year, most of it ends up in landfills or incarnated, leading to further environmental issues [8]. The SCG biochar is known for having O-surface sites, high surface area and constituent other elements. Hence it is important to study the composition of materials to effectively design its application. [9]

The most popular way to synthesize highly crystalline and porous biochar from sustainable biomass products is considered pyrolysis. During pyrolysis reaction the material undergoes physical and chemical transformation in absence of oxygen. Hence, it is very useful to understand the resultant constituents after pyrolysis of biomass material. EDS (Energy Dispersive X-Ray Spectroscopy) is a chemical microanalysis technique that is used in conjunction with SEM to examine the material's elemental makeup. The EDS analysis makes use of the material's distinctive X-ray spectra. The goal of this study is to use a combination of SEM/EDS (Jeol JSM -7200 F) techniques to evaluate the physical and chemical alterations in SCG caused by pyrolysis. A high temperature/pressure pyrolysis reaction was used to create SCG biochar. SCG was heated to 800°C at a rate of 20°C/min for 2 hours at autogenic pressure of roughly 150 bar. The resulting biochar was crushed and sieved to fewer than 100 microns in fineness. The structural morphology of SCG biochar was next studied using SEM, and the quantitative determination of elemental atomic percent (At percent) using EDS was done using the ZAF method.

SEM analysis revealed that carbon rich biochar particles with particle sizes ranging from 1-10 µm were obtained (figure 1). EDS analysis of the same area using AREA analysis revealed that the biochar contained huge amounts of carbon, nitrogen and oxygen with some trace amounts of magnesium and calcium which are typical for biomass related material (figure 2). This carbon biochar can be used for reinforcement of polymer composites, waste water treatment or energy storage applications.



Element	Atom (%)
Carbon (C)	75.34
Nitrogen (N)	17.15
Oxygen (O)	6.85
Magnesium (Mg)	0.45
Calcium (Ca)	0.20
Total	100

Figure 1. SEM Micrograph and EDS elemental composition of SCG Biochar

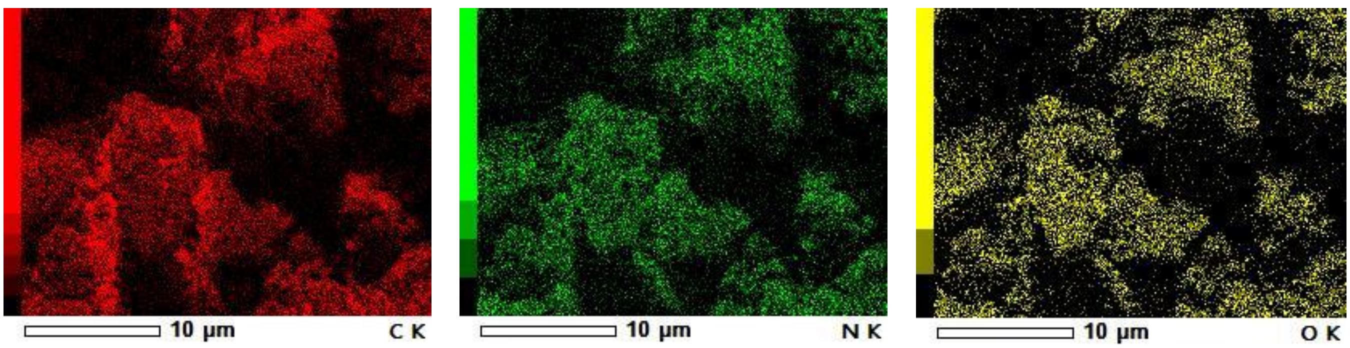


Figure 2. EDS micrographs showing Carbon, Nitrogen and Oxygen distribution in SCG Biochar

References:

[1] Mohammed, Z., Jeelani, S., & Rangari, V. (2021). Materials Letters, 292, 129678.

[2] Mohammed, Z., Jeelani, S., & Rangari, V. (2020). JOM, 72(4), 1523-1532.

[3] Mohammed, Zaheeruddin, Shaik Jeelani, and Vijaya Rangari. Microscopy and Microanalysis 25.S2 (2019): 1112-1113.

[4] Giorcelli, Mauro, et al. ACS Applied Electronic Materials 3.2 (2021): 838-844.

[5] Mohammed, Zaheeruddin, Shaik Jeelani, and Vijaya Rangari. Composites Part C: Open Access (2021): 100221.

[6] Idrees, Mohanad, et al. Additive Manufacturing 36 (2020): 101525.

[7] Hembrick-Holloman, Vincent, et al. Journal of Materials Research and Technology 9.6 (2020): 13729-13739.

[8] Alhelal, Ahmed, et al. Journal of Composite Materials (2021): 00219983211002237.

[9] Andrade, Tatiana Santos, et al. Chemical Engineering Journal Advances 4 (2020): 100061.

https://doi.org/10.1017/S1431927622003105 Published online by Cambridge University Press