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PRODUCTION OF A NEW MAGNETIC NANOCOMPOSITE FROM WEEDS BIOCHAR

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Abstract

In this study, the synthesis and characterization of a novel composite material was carried out by co-precipitation method. Weeds biochar was successfully transferred to a magnetic material via embedding $MnFe_2O_4$ nanoparticles to its structure. The synthesized spinel ferrite composite was characterized with scanning electron microscopy and vibrating sample magnetometer spectroscopy and the results of the analyses of non-magnetic and magnetic material were compared.

Key words: weeds, biochar, magnetic composite, magnetite nanoparticles, characterization

1. Introduction

Magnetic ferrite MFe_2O_4 (M denotes a divalent metal such as Fe^{II}, Mn^{II}, Cu^{II}, Zn^{II}) nanoparticles (NPs) possess special optical, electrical, and magnetic properties, thus have recently attracted much attention in magnetic storage, biosensing, disease diagnosis, catalysis, and environmental analysis [1]. However preventing NPs aggregation, a base material is needed. Biochar, such as wood charcoals and crop residue derived chars, refer to thecarbon rich residues from pyrolysis or incomplete combustion of biomass [2]. Agricultural wastes or residues are wide available low cost materials to produce biochar as well as biooil and gases [3]. As such, combining the advantages of cheap biochar and magnetic NPs with an industrial friendly production method may be a promising solution of the magnetic biochar nanocomposite. This study aimed to develop a new magnetic biochar composite via a low cost method. Weeds were firstly converted to biochar and $MnFe_2O_4$ NPs were embedded to the weeds based biochar. The synthesized magnetic material was characterized and compared with its non-magnetic form.

2. Materials and Method

2.1. Preparation of the weeds based biochar

The weeds were supplied from the campus of Dicle University in Diyarbakır, Turkey, and then washed, dried and sized to 1- 2 cm in length. The preparation of weeds biochar was performed in a horizontal stainless-steel tubular reactor (7.0 cm diameter x 100 cm length) under nitrogen atmosphere (99.99%) flow (100 mL/min) at the rate of 5 ^{0}C/min at 500 ^{0}C for 1 h. Subsequently, the char product was cooled to room temperature, washed with hot deionized water and HCl of 0.1 M until the pH of the washing solution reached 6-7, and dried at 105 ^{0}C for 12 h and then sieved between 80 and 40 meshes.

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2.2. Preparation of the magnetic composite

In order to synthesize magnetic composite, co-precipitation method was used as follows: The stoichiometric amounts of $FeCl_3$ and $MnCl_2$ were dissolved in distilled water. A certain amount of weeds biochar was added to the mixture under vigorous stirring. Then NaOH solution was used to adjust the pH of the solution to the range of 10-11. After pH adjustment, the solution was kept at 100 ^{0}C for 4h. Then, the solution was filtrated, washed with distilled water several times and dried at 105 ^{0}C for 24 h. The synthesized material was stored in glass bottles.

2.3. Characterization studies

The surface morphology was identified by the scanning electron microscopy (SEM) instrument (Carl Zeiss Ultra Plus, UK). Micrographs of samples were observed by the assistance of coated with platinum, operating at 10 kV.
Vibrating sample magnetometer (VSM 7404, Lake Shore Cryotronics, USA) was utilized to magnetic features of the synthesized material.

3. Results and Discussion

3.1. SEM analysis

SEM micrographs of weeds, weeds biochar and $MnFe_2O_4$/weeds biochar composite are indicated in Figure 1. The surfaces of the materials are different from each other and the successfull loading of $MnFe_2O_4$ NPs can be obserevd from SEM images.

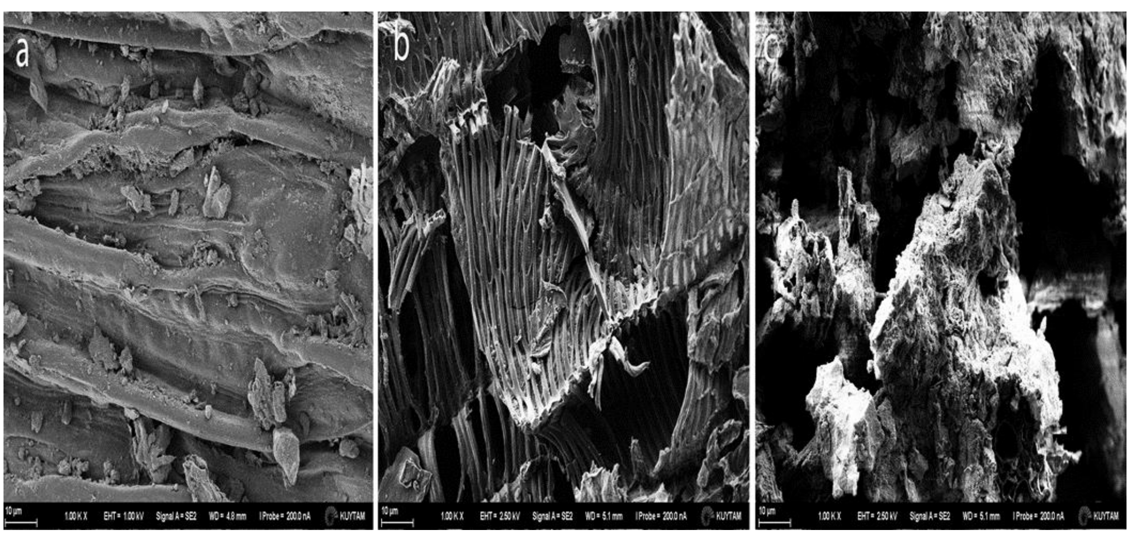

Figure 1. SEM images of weeds (a), weeds biochar (b) and $MnFe_2O_4$/weeds biochar composite (c).

3.2. VSM analysis

VSM curves of the $MnFe_2O_4$/weeds biochar is seen in Figure 2 and indicates the magnetic property of the synthesized material. Also the inset figure shows that the synthesized composite material is magnetically separable.

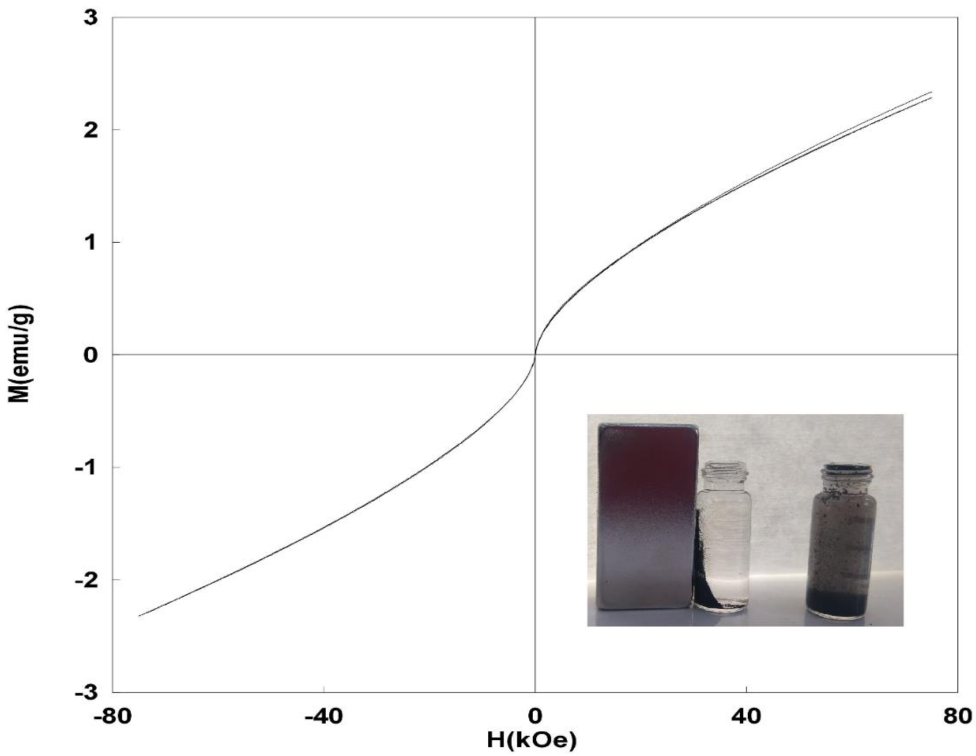

Figure 2. VSM curves of $MnFe_2O_4$/weeds biochar composite.

Conclusions

Development of a new magnetic material was achieved from weeds based biochar. The advantages of biochar features were combined with magnetic separabilty and then the functionailty of the biochar was enhanced. This study indicated the possible usage of weeds for the production of magnetic materials. The synthesized material was characterized in terms of surface structure and magnetic properties and the results confirmed the successful embedding of the $MnFe_2O_4$ nanoparticles to the weeds biochar structure.

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