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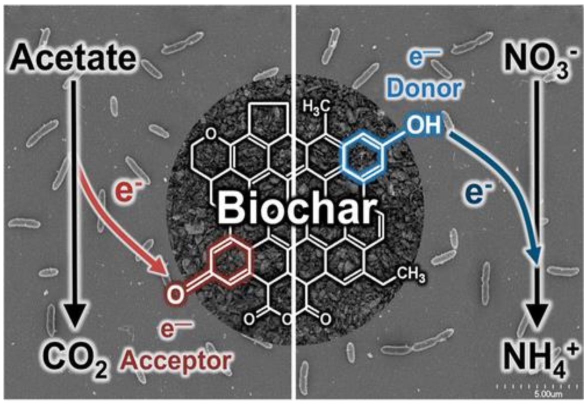
Determining the Electron Storage Capacities and Redox Reversibility of Black Carbon and Humic Acid

P.C. CHIU[1*], D. XIN[1], M. XIAN[1]

[1]Civil & Environ. Engineering, Univ. of Delaware, Newark, DE 19716, USA (*correspondence: pei@udel.edu)

Black carbon is a carbonaceous component ubiquitous in natural environments. Black carbon has also been evaluated as adsorbent for water treatment, sediment remediation, and other engineering applications. We previously showed black carbon materials such as soot, graphite, and char are not merely chemically passive sorbents but redox-active catalysts that can mediate abiotic redox reactions [1]. We subsequently demonstrate that microorganisms can take advantage of the redox properties of black carbon and use it as a rechargeable geobattery; i.e., as a reversible electron donor and acceptor to support metabolic redox processes [2]. A diagram illustrating the black carbon-mediated redox transformation is below.



We found that the biochar could provide *ca*. 0.86 mmol of electrons/g reversibly for microbial transformation. Because microbes cannot physically access the interior of biochar they presumably can utilize only a fraction of the biochar's total electron storage capacity (ESC). We developed a chemcial method to determine the total ESC of the biochar and other carbonaceous geobatteries (e.g., humic acid) and investigated the reversibility of the ESC. The environmental implications, potential engineering applications, and the biogeochemical role of ESC-rich black carbon will be discussed, particularly with respect to sustainable soil and groundwater remediation.

[1] Oh and Chiu (2009) *Environ. Sci. Technol.*, **43**, 6983-88.
[2] Saquing, Yu and Chiu (2016) *Environ. Sci. Technol. Lett.*, **3**, 62-66.

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