World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:16, No:12, 2022

Investigation of Different Surface Oxidation Methods on Pyrolytic Carbon

Authors : Lucija Pustahija, Christine Bandl, Wolfgang Kern, Christian Mitterer

Abstract : Concerning today´s ecological demands, producing reliable materials from sustainable resources is a continuously developing topic. Such an example is the production of carbon materials via pyrolysis of natural gases or biomass. The amazing properties of pyrolytic carbon are utilized in various fields, where in particular the application in building industry is a promising way towards the utilization of pyrolytic carbon and composites based on pyrolytic carbon. For many applications, surface modification of carbon is an important step in tailoring its properties. Therefore, in this paper, an investigation of different oxidation methods was performed to prepare the carbon surface before functionalizing it with organosilanes, which act as coupling agents for epoxy and polyurethane resins. Made in such a way, a building material based on carbon composites could be used as a lightweight, durable material that can be applied where water or air filtration / purification is needed. In this work, both wet and dry oxidation were investigated. Wet oxidation was first performed in solutions of nitric acid (at 120 °C and 150 °C) followed by oxidation in hydrogen peroxide (80 °C) for 3 and 6 h. Moreover, a hydrothermal method (under oxygen gas) in autoclaves was investigated. Dry oxidation was performed under plasma and corona discharges, using different power values to elaborate optimum conditions. Selected samples were then (in preliminary experiments) subjected to a silanization of the surface with amino and glycidoxy organosilanes. The functionalized surfaces were examined by X-ray photon spectroscopy and Fourier transform infrared spectroscopy spectroscopy, and by scanning electron microscopy. The results of wet and dry oxidation methods indicated that the creation of functionalities was influenced by temperature, the concentration of the reagents (and gases) and the duration of the treatment. Sequential oxidation in aq. HNO_3 and H_2O_2 results in a higher content of oxygen functionalities at lower concentrations of oxidizing agents, when compared to oxidizing the carbon with concentrated nitric acid. Plasma oxidation results in non-permanent functionalization on the carbon surface, by which it´s necessary to find adequate parameters of oxidation treatments that could enable longer stability of functionalities. Results of the functionalization of the carbon surfaces with organosilanes will be presented as well.

Keywords : building materials, dry oxidation, organosilanes, pyrolytic carbon, resins, surface functionalization, wet oxidation
Conference Title : ICDGCM 2022 : International Conference on Diamond, Graphite and Carbon Materials
Conference Location : Rome, Italy
Conference Dates : December 15-16, 2022