Investigation of the Pyrolysis and Chemical Activation of Expanded Polystyrene Foam to Form Activated Carbon

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The accumulation of expanded polystyrene foam waste in landfills and oceans is an increasing global problem. Every year in the U.S. alone, a staggering 900 million kilograms of polystyrene foam are thrown away, making polystyrene one of the main components of landfills. Because it is neither economically feasible nor commercially viable to recycle polystyrene, it is considered a non-renewable material. Further, since polystyrene takes over 500 years to degrade, its impact on the environment is long lasting. Because polystyrene is composed of over 92% carbon by mass, we hypothesized that we might be able to convert polystyrene into pure activated carbon that could be used for water filtration or air purification. We investigated various pyrolytic routes for the carbonization of polystyrene, but found that high temperature pyrolysis (above 500°C) was ineffective due to rapid volatilization of the polystyrene and its decomposition byproducts. We therefore developed an innovative low temperature process for carbonization to achieve yields over 50%. We investigated simple chemical reagents which, coupled with heating, effectively etched the carbon to achieve a surface area of over 300 m2/g. Furthermore, the resulting activated carbon was effective at removing a variety of chemicals from contaminated water solutions. In summary, our results demonstrate a positive proof of concept for a solution that successfully addresses two global problems: accumulation of polystyrene waste and lack of clean water throughout the third world.

Awards Won:
Sigma Xi, The Scientific Research Honor Society: Second Physical Science Award of $1,000