CRADA facts

DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY

COMBUSTION PROJECT

SURFACE CHARACTERIZATION OF UNBURNED CARBON FROM COAL COMBUSTION FLY ASH

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Capabilities

The development of processes and technologies critical to the clean, efficient, and affordable generation of electric power from coal firing requires investigation of these processes and technologies at their most fundamental levels. Researchers can use the surface analysis laboratory at the U.S. Department of Energy's Federal Energy Technology Center to investigate the chemistry of solid surfaces following a variety of processing treatments.

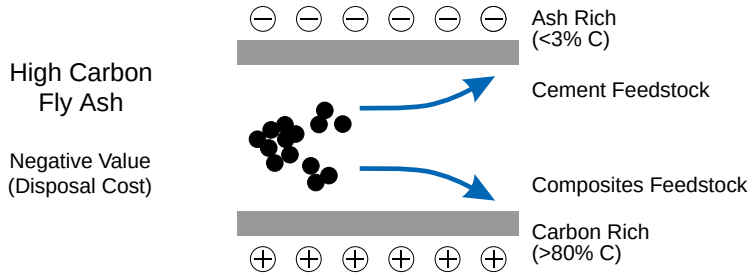
This work involves the examination of factors critical to the clean and economical utilization of fly ash from coal combustion. Recent efforts to alter combustion conditions in order to reduce the environmental consequences of coal firing have led to degradation of fly ash quality through the incorporation of additional unburned carbon. While low-carbon fly ash has been used as a construction material, high-carbon fly ash has a negative value because of its associated disposal costs. Dry electrostatic separation (DES) is being investigated as a possible low-cost and efficient processing technology for the separation of high-carbon fly ash into marketable commodities.

The behavior of fly ash in DES is governed by its surface properties, which can change dramatically based on the handling of the ash. X-ray photoelectron spectroscopy (XPS) was used at each step of a test DES processing scheme to determine the chemical composition of the ash surface. Two major forms of carbon were identified on the fly ash surface using XPS. Fly ash particles were found to behave differently during DES, depending on which major form of carbon was present on their surfaces. Further work will focus on closer examination of the carbon-containing surfaces in order to understand the chemical properties affecting particle behavior. Surface analysis will also be used to help understand what properties of the carbon-containing particles can be correlated with their optimal use as feedstocks for sorption and catalytic processes.

Surface Characterization of Unburned Carbon From Coal Combustion Fly Ash

Opportunities

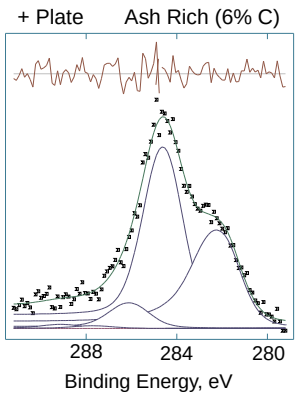
Surface analysis using XPS and secondary ion mass spectrometry (SIMS) has found wide use in investigating the surface chemical properties of a variety of solid materials related to coal utilization. The chemical forms of the elements present on catalysts, sorbents, fly ash, coal, and pyrite have all been studied, following their exposure to various processing conditions, in an effort to understand the chemical changes that have occurred. Surfaces of solid materials such as boiler tubes, electrodes, and gas sensors from coal processing devices have also been examined to help determine mechanisms for wear and corrosion. Past CRADA work has used XPS to characterize coating processes aimed at preventing corrosion of stainless steel surfaces under extreme conditions. The corrosion of electrode surfaces during the magnetohydrodynamic combustion of coal has also been studied.



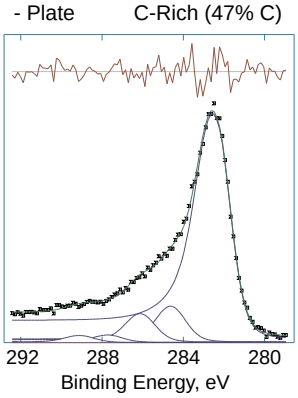
Dry Electrostatic Separation of Fly Ash Into Products With Positive Values

X-ray Photoelectron Spectroscopy

- Identification of elements other than H and He on solid surfaces.
- Oxidation state determination of elements present.
- Analysis depth of approximately 50Å - larger when combined with ion sputtering.
- Analysis lateral resolution typically 150 µm - elemental and chemical oxidation-state mapping capabilities.



XPS spectrum of the ash-rich fraction of separated fly ash with the major component at 284.6 eV, characteristic of CH_X carbon



XPS spectrum of the C-rich fraction of separated fly ash with the major component at 282.0 eV, characteristic of carbidic carbon

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