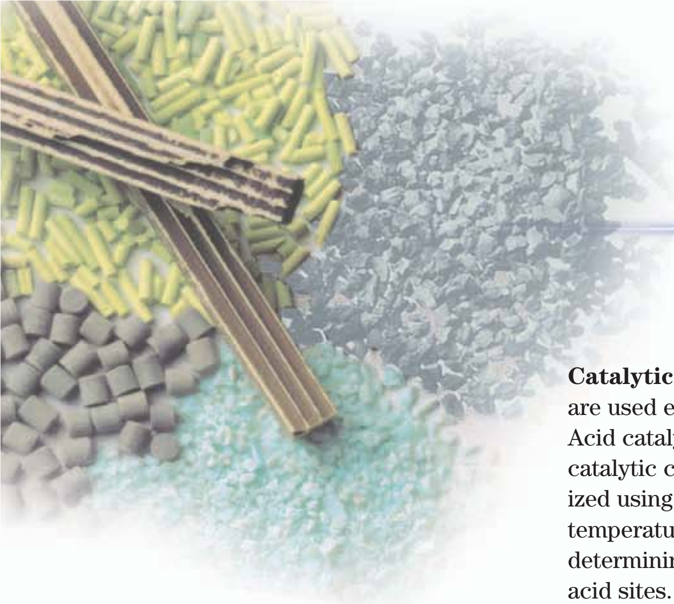
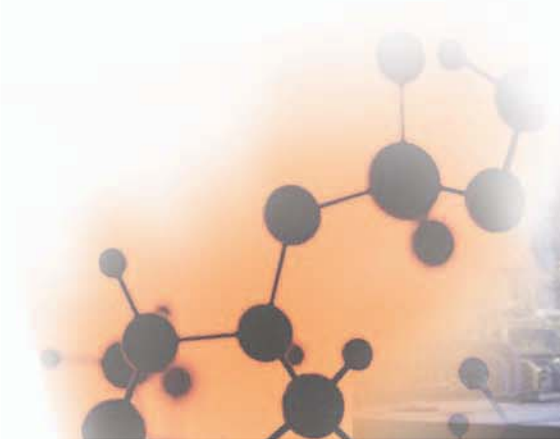


Typical ChemiSorb Applications

Catalysts – The active surface area and pore structure of catalysts have great influence on reaction rates and yield of product. Limiting the pore size allows only molecules of desired sizes to enter and leave; creating a selective catalyst that will produce primarily the desired product. Chemisorption experiments are valuable for the selection of catalysts for a particular purpose, qualification of catalyst vendors, and the testing of a catalyst's performance over time to establish when the catalyst should be reactivated or replaced.

Fuel Cells – Platinum-based catalysts including Pt/C, PtRu/C, and PtRuIr/C may be characterized by temperature-programmed reduction to determine the number of oxide phases or by pulse chemisorption to characterize the metal surface area, metal dispersion, and average crystallite size.

Partial oxidation – Manganese, cobalt, bismuth, iron, copper, and silver oxides are often used for the gas-phase oxidation of ammonia, methane, ethylene, propylene, etc. Temperature-programmed oxidation and temperature-programmed desorption may be used to measure the heat of desorption of oxygen from these catalysts and the heat of dissociation of oxygen from the metal oxide.

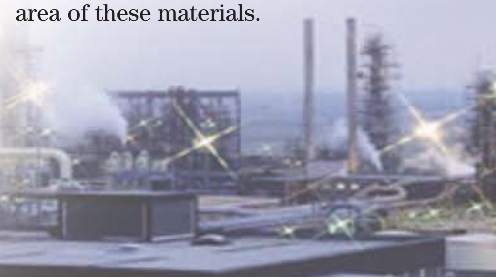


Catalytic cracking – Catalytic processes are used extensively for refining petroleum. Acid catalysts such as zeolites are used for catalytic cracking and are often characterized using ammonia chemisorption and temperature-programmed desorption for determining the number and strength of the acid sites.

Catalytic-reforming catalysts containing platinum, rhenium, tin on silica, alumina, or silica-alumina are used for the production of hydrogen, aromatics, and olefins. These catalysts are often characterized using pulse chemisorption techniques to determine the number of active sites, the percent metal dispersion, and average crystallite size.

Isomerization catalysts such as small-pore zeolites (mordenite and ZSM-5) containing noble metals (typically platinum) are used to convert linear paraffins to branched paraffins and thus increase the octane number and value for blending gasoline. Temperature-programmed reduction and pulse chemisorption are often combined to characterize these catalysts.

Hydrocracking, hydrodesulfurization, and hydrodenitrogenation catalysts are typically composed of metal sulfides (nickel, tungsten, cobalt, and molybdenum). Hydrocracking catalysts are used for processing feeds containing polycyclic aromatics that are unsuitable for typical catalytic cracking processes. The hydrocracking process is used for upgrading these low-value products to gasoline and diesel fuel. Hydrodesulfurization and hydrodenitrogenation are used for removing sulfur and nitrogen, respectively, from petroleum feeds. Both sulfur and nitrogen are catalytic poisons and also are the source of pollution (acid rain) if they are not removed from gasoline and diesel fuel. Temperature-programmed reduction and oxygen chemisorption are used to characterize the oxide phases and active surface area of these materials.



Fischer-Tropsch synthesis uses cobalt and iron-based catalysts to convert syngas (carbon monoxide and hydrogen) to hydrocarbons larger than methane. The Fischer-Tropsch processes are of great importance as they provide hydrocarbons that are rich in hydrogen and do not contain sulfur or nitrogen. These hydrocarbons are a potential liquid fuel that is easily transported and distributed, and can then be reformed to hydrogen to supply fuel cells. These catalysts are often characterized by pulse chemisorption and temperature-programmed desorption to determine the metal surface area and the average size of the metal crystallites.