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Characterization of highly active sites on the surface of oxide catalysts by electron paramagnetic resonance

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Electron paramagnetic resonance (EPR) with the use of suitable spin probes can be used to study very active sites on the catalyst surface capable of abstracting an electron or a hydrogen atom, or donating an electron at low temperatures. Without any doubt, such sites can be also very active in many other heterogeneous chemical and catalytic reactions of high practical importance. However, their role in real catalytic reactions practically has not been studied until now. In this presentation several types of highly active sites and methods of their characterization by EPR will be discussed.1). Electron-acceptor sites capable of abstracting an electron from aromatic molecules with ionization potentials ranging from 7 to 9.2 eV are present on the surface of many acid catalysts. Their strength correlates with the strength of the catalyst acid sites. Methods for quantitative characterization of such sites on the surface of fresh and operating catalysts as well as correlations with the activity in selected catalytic and solid-state reaction will be reported.2). Electron-donor sites characterized by electron donation to trinitrobenzene molecule exist on the surface of such oxides as Al2O3, ZrO2, MgO, CaO and some other. The role of such sites in stabilization of Pd species highly active in CO oxidation will be demonstrated.3). Oxygen radicals O- are capable of abstracting a hydrogen atom from most organic molecules, including alkanes. However such sites can be observed directly by EPR only on some materials, e.g. MgO, and only at low temperatures.Methods for characterization of O- radicals that are not observed directly and their possible role in selective oxidation reactions will be discussed.Characterization of C12A7 electrides and O- radicals inside their cages by EPR will be shown.

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