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The adsorption of glycine on alumina: A search for fundamental mechanisms of surface complexation

Adsorption and surface complexation of biological molecules on inorganic materials are actively studied in such diverse fields as chemistry (geochemistry, biochemistry), biotechnology (medical implants, biosensors, tissue engineering, bioelectronics, biomimetics, artificial photosynthesis), radiation technology (radiation damage and detection), colloid chemistry, surface chemistry and physics, etc. The surface complexation and hence uptake of glycine on Al2O3 from solution was measured, at different pH, and glycine concentrations, by titration. Experimentally derived uptake diagrams (amount adsorbed versus pH) are based on simple surface-complexation models which give the best fit to the titration data. And yet these models are unlikely to be particularly accurate because of fundamental assumptions made about surface-proton coordination, stoichiometry, and exchange between surface and solution, and hence surface valency and the simple electrostatic picture used to model the surface-complex-water interface. Whether titration measurements yield particularly quantitative results and whether adsorption is indeed simply driven by proton exchange is not definitive. Photoemission spectroscopy provides a way to probe the chemical state of each amino-group: e.g. zwitterions can be observed by the energy shifts of the N 1s and O 1s levels.

High resolution x-ray photoelectron spectroscopy performed at the Taiwan synchrotron is used to yield a wealth of information about the extent of adsorption at various pH's, the character of each adsorbate (whether zwitterionic, basic, acidic), and the number of discrete surface sites involved in the adsorption. Titration results show a higher affinity of glycine to alumina at low pH, while valence band photoemission results show the presence of carboxyl groups on the surface and that the amine group may be absent. Drying might indeed alter the chemistry of adsorbed species. A number of plausible surface structures are proposed.

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