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Innovative oxide materials for electrochemical energy conversion

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Research in functional materials has progressed from those materials exhibiting structural to electronic functionality. The study of ion conducting ceramics ushers in a new era of "chemically functional materials." This chemical functionality arises out of the defect equilibria of these materials, and results in the ability to transport chemical species and actively participate in chemical reactions at their surface. Moreover, this chemical functionality provides a promise for the future whereby the harnessing of our natural hydrocarbon energy resources can shift from inefficient and polluting combustion - mechanical methods to direct electrochemical conversion. The unique properties of these materials and their applications will be described. The focus will be on the application of ion conducting ceramics to energy conversion and storage, chemical sensors, chemical separation and conversion, and life support systems. Results presented will include development of record high power density (3 kW/kg) solid oxide fuel cells, NO_x/CO species selective solid-state sensors, high yield membrane reactors, and regenerative life support systems that reduce CO_2 to O_2 and solid C.