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Energy Materials in Extreme Environments

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The critical shortage of abundant, affordable, and clean energy calls upon novel materials with extreme properties for energy production, storage, conversion, and transfer that are superior to materials that now exist or are in use today. Twenty-first century energy technology also demands enhanced performance from existing materials under extreme environments of pressure, temperature, chemistry, radiation, and electromagnetic fields. Investigating the behavior of materials in extreme pressures and temperatures, in particular, provides the fundamental knowledge needed to address these problems. These studies are leading to the discovery of both new materials with enhanced performance as well as new physical and chemical phenomena, and take advantage of advances at national x-ray, infrared, neutron, and laser facilities. An important example is the continued study of hydrogen-rich materials, from investigations of transformations in pure hydrogen, which has now been pressurized well above 300 GPa, to the discovery of new hydrogen storage materials and hydriding reactions induced by extreme conditions. Other examples include studies of carbon-based materials, which are also deepening our understanding of carbon sources and cycling within the planet.