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Technology Title and Brief Description	Intellectual Property Status
Metal oxide promoters for improving the reactivity and capacity of oxygen carriers for the chemical looping combustion process This invention provides an oxygen carrier comprised of a plurality of metal oxide particles in contact with a plurality of MgO promoter particles. The MgO promoter particles increase the reaction rate and oxygen utilization of the metal oxide when contacting with a gaseous hydrocarbon at a temperature greater than about 725 degrees Celsius. The promoted oxide solid is generally comprised of less than about 25 wt.% MgO, and may be prepared by physical mixing, incipient wetness impregnation, or other methods known in the art. The oxygen carrier exhibits a crystalline structure of the metal oxide and a crystalline structure of MgO under XRD crystallography, and retains these crystalline structures over subsequent redox cycles. In an embodiment, the metal oxide is Fe_2O_3 and the gaseous hydrocarbon is comprised of methane.	U.S. non-provisional patent application filed 5/22/2012
Method to improve superalloy oxidation resistance by surface treatment U.S. Patent No. 7,553,517, owned by DOE, describes a method of infusing Ce or other reactive metals into the surface of metal alloys. This invention is a related invention that provides a method to apply a reactive metals treatment directly to the substrate ahead of a bond coat, thereby reducing the oxidation rate.	U.S. non-provisional patent application filed 2/1/2012
Process to produce methane-rich syngas from coal/waste/biomass with multi-functional catalyst/capture agent The invention provides a gasification process for the production of a methane-rich syngas at temperatures exceeding 700°C through the use of an alkali hydroxide MOH, using a gasification mixture comprised of at least 0.25 moles and less than 2 moles of water for each mole of carbon, and at least 0.15 moles and less than 2 moles of alkali hydroxide MOH for each mole of carbon. These relative amounts allow the production	U.S. non-provisional patent application filed 9/4/2011

of a methane-rich syngas at temperatures exceeding 700°C by enabling a series of reactions which generate H2 and CH4, and mitigate the reforming of methane. The process provides a methane-rich syngas comprised of roughly 20% (dry molar percentage) CH4 at temperatures above 700°C, and may effectively operate within an IGFC cycle at reactor temperatures between 700-900°C and pressures in excess of 10 atmospheres.	
Triazolium-based ionic liquids as CO_2 capture solvents and membranes This invention relates to compositions of matter that are ionic liquids, the compositions comprising substituted 1,2,3-triazolium cations combined with any anion. Compositions of the invention should be useful in the separation of gases and, perhaps, as catalysts for many reactions.	U.S. non-provisional patent application filed 9/1/2011
A process for the separation of CO_2 gas from a stream with other gas components This invention provides an apparatus and method for gas separation through the supersonic expansion and subsequent deceleration of a gaseous stream. The gaseous constituent changes phase from the gaseous state by desublimation or condensation during the acceleration producing a collectible constituent, and an oblique shock diffuser decelerates the gaseous stream to a subsonic velocity while maintain the collectible constituent in the nongaseous state. Following deceleration, the carrier gas and the collectible constituent at the subsonic velocity are separated by a separation means, such as a centrifugal, electrostatic, or impingement separator. In an embodiment, the gaseous stream issues from a combustion process and is comprised of N_2 and CO_2.	U.S. non-provisional patent application filed 8/8/2011
Regenerable CO_2 removal sorbents with modified clay materials This invention is a sorbent for the removal of carbon dioxide from a gas stream. The sorbent is an organoclay substrate having quaternary ammonium cations to which polar, nucleophilic moieties are added. Also included are methods of using and preparing the modified organoclay sorbent.	U.S. non-provisional patent application filed 8/2/2011
Regenerable mixed copper-iron-inert support oxygen carriers for solid fuel chemical looping combustion The invention provides an oxygen carrier for a chemical looping cycle, such as the chemical looping	U.S. non-provisional patent application filed 6/14/2011

combustion of solid carbonaceous fuels, such as coal, coke, coal and biomass char, and the like. The oxygen carrier is comprised of at least 24 weight % (wt%) CuO, at least 10 wt% Fe2O3, and an inert support, and is typically a calcine. The oxygen carrier exhibits a CuO crystalline structure and an absence of iron oxide crystalline structures under small-molecule XRD crystallography, and provides an improved and sustained combustion reactivity in the temperature range of 600oC-1000oC particularly for solid fuels such as carbon and coal.	
Carbon treatment of gasifier refractory liners to improve wear performance The invention consists of refractory brick comprised of Cr2O3 and carbon for operation in the slagging environment of an air-cooled gasifier. The Cr2O3 provides a porous refractory brick, with carbon residing within the pores. The brick may be further comprised of Al2O3. The air-cooled gasifier generates a liquefied slag in contact with the refractory brick and generally operates at temperatures between 1250 oC and 1575oC and pressures between 300 psi to 1000 psi, with oxygen partial pressures generally between 10-6 and 10-10 atm. The refractory brick performs without substantial chromium carbide formation in the low oxygen partial pressure environment. The inclusion of carbon without chromium carbide formation provides for significant mitigation of slag penetration and significantly reduced refractory wear.	U.S. non-provisional patent application filed 4/7/2011
Fiber supported ionic liquid sorbents This invention relates to the production of a fabricated fiber having an asymmetric polymer network and having an immobilized liquid such as an ionic liquid within the pores of the polymer network. The process produces the fabricated fiber in a dry-wet spinning process using a homogenous dope solution, providing significant advantage over current fabrication methods for liquid-supporting polymers. The fabricated fibers may be effectively utilized for the separation of a chemical species from a mixture based on the selection of the polymer, the liquid, and the solvent utilized in the dope.	U.S. non-provisional patent application filed 10/21/2010
Chemical looping air separation unit with oxy-fuel combustion This invention allows for oxygen separation from air by utilizing an initial oxygen carrier which undergoes an	U.S. non-provisional patent application filed 10/21/2010

endothermic reduction reaction to produce a carrier product and gaseous oxygen. The gaseous oxygen is withdrawn, and the carrier product is subsequently further reduced with a fuel in a combustion process, releasing heat and generating an oxygen acceptor. The oxygen acceptor is oxidized in an exothermic reaction. The method thus couples the exothermic oxidation reaction, the endothermic reduction reaction, and the chemical energy supplied by the fuel for a new heat release.	
Heterostructured photocatalysts for reduction of CO_2 with visible light The method provides for use of sensitized photocatalyst for the photocatalytic reduction of CO_2 under visible light illumination. The photosensitized catalyst is comprised of a wide band gap semiconductor material, a transition metal co-catalyst, and a semiconductor sensitizer. The semiconductor sensitizer is photoexcited by visible light and forms a Type II band alignment with the wide band gap semiconductor material. The wide band gap semiconductor material and the semiconductor sensitizer may be a plurality of particles, and the particle diameters may be selected to accomplish desired band widths and optimize charge injection under visible light illumination by utilizing quantum size effects. In a particular embodiment, CO_2 is reduced under visible light illumination using a $CdSe/Pt/TiO_2$ sensitized photocatalyst with H_2O as a hydrogen source.	U.S. non-provisional patent application filed 10/13/2010
Process for minimization of steam requirements and enhancement of WGS with warm gas temperature CO_2 sorbent The invention utilizes a hydroxide sorbent for humidification and CO_2 removal from a gaseous stream comprised of CO and CO_2 prior to entry into a water-gas-shift reaction, in order to decrease CO_2 concentration and increase H_2O concentration and shift the water-gas shift reaction toward the forward reaction products CO_2 and H_2. The hydroxide sorbent may be utilized for absorption of CO_2 exiting the water-gas shift reactor, producing an enriched H_2 stream. The disclosure further provides for regeneration of the hydroxide sorbent at temperature approximating water-gas shift conditions, and for utilizing H_2O product liberated as a result of the CO_2 absorption.	U.S. non-provisional patent application filed 9/22/2010
Process for CO2 capture from Mg(OH)2 sorbent at high pressure and moderate temperature gas streams This invention is a process for CO_2 separation using a regenerable $Mg(OH)_2$ sorbent. The process absorbs CO_2	U.S. non-provisional patent application filed 3/10/2010

through the formation of $MgCO_3$ and releases water product H_2O. The $MgCO_3$ is partially regenerated through direct contact with steam, which acts to heat the magnesium carbonate to a higher temperature, provide heat duty required to decompose the magnesium carbonate to yield MgO and CO_2, provide an H_2O environment over the magnesium carbonate thereby shifting the equilibrium and increasing the potential for CO_2 desorption, and supply H_2O for rehydroxylation of a portion of the MgO. The mixture is polished in the absence of CO2 using water product H_2O produced during the CO_2 absorption to maintain sorbent capture capacity. The sorbent now comprised substantially of $Mg(OH)_2$ is then available for further CO_2 absorption duty in a cyclic process.	
Temperature booster for superheat and reheat in oxy-fuel retrofit of power plants This invention overcomes issues associated with retrofit of existing air-fired boiler to oxy-fuel combustion by utilizing oxy-fuel flames in an existing boiler designed for air-firing in a configuration with a auxiliary heater that obviates the need to mimic air-fired conditions in order to meet existing dry steam load demands. The method redistributes the release of the total chemical energy in the fuel such that the heat transfer requirements in the radiant zone of the boiler are dissociated from the convective heat transfer requirements in the convective zone of the boiler. The method continues to utilize superheat or reheat capabilities in the convective zone of the existing boiler and generates significant flexibility, allowing oxy-fuel combustion in a wide range of existing boilers and configurations.	U.S. non-provisional patent application filed 2/4/2010
Computationally optimized homogenization heat treatment of metal alloys This invention allows for computational optimization of homogenization heat treat for metal alloys based on initial micosegregation profiles determined with a Scheil-Gulliver model and diffusion in the primary matrix phase determined through numerical solution of multicomponent diffusion equations. The method generally comprises: identifying a primary matrix phase and characteristic diffusion length, determining microsegregation profiles and an initial incipient melting point upon solidification, simulating homogenization and determining the resulting microsegregation profiles and resulting incipient melting point, and repeating the simulated homogenization based on the resulting incipient melting point until sufficient homogeneity is obtained, as judged by an operator.	U.S. non-provisional patent application filed 8/11/2009

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Combustible fluids as the motive fluid for solid fuels in high temperature oxy-combustion systems A solid fuel such as pulverized coal is typically delivered to power plant burners using pressurized air as the motive fluid. The unique aspect of this invention is in the use of hydrocarbon gases or liquids as the motive fluid for delivery of solid fuels such as pulverized coal to the combustor.	Invention disclosed