C-01

Recovery of Perfluoro Surfactant Anions from Wastewater by Interlayering in Hydrotalcite-like Compounds

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Perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) have recently been concerned as new global contamination that would accumulate in the tissues of higher animals including human body. Considering that these compounds are still of great importance in materials processing such as PTFE polymerization, silicon etching process, the recovery and the reuse of these compounds are worth studying. We have developed a new treatment method using an interlayering technique using hydrotalcite-like compounds for this purpose, which has high performance in technological as well as economical aspects.

C-02

DEVELOPMENT OF ADSORPTION GELS FOR HEAVY METALS FROM ORANGE AND APPLE JUICE RESIDUE

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Environmental friendly and sustainable separation unit process has attracted much attention in recent years. Recycling of natural materials in order to reduce the organic pollution in one hand and cost effective treatment processes by the application of such natural biopolymers on the other, are the main focuses of the present investigation. Experimentalresults revealed that after simple chemical modification by means of saponification, apple and orange juice residues can be potentially applied for the removal of heavy metals from environment.

C-03

Mechanical Properties of Kenaf Reinforced Green Sustainable Composite

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Green sustainable composites, made of kenaf fiber and poly-L-lactic acid (PLLA) resin, were both hot-press and solvent-cast molded and their mechanical properties were investigated. Young's modulus and the tensile strength of the kenaf / PLLA composites were comparable to those of traditional composites. High mechanical performance of these composites is considered to attribute to the strong interfacial interaction between the kenaf fiber and PLLA. Kenaf reinforced biodegradable composite can be a good candidate as

the alternatives to the conventional composites.

C-04

Possibility of Polycarbosilanes for Chemical Recycle Polymers : Trifluoromethanesulfonic acid-Catalyzed Decomposition of Polycarbosilanes

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The developments of the catalytic, clean, and ecological decompositions of engineering polymers offer the possibility for new chemical recycle systems. Herein, we wish to report that the decomposition of polycarbosilanes by the catalytic amount of trifluoro- methanesulfonic acid (TfOH). Polycarbosilane (1) was perfectly decomposed by the treatment of 40-60 mol% of TfOH in clued toluene at room temperature within practical reaction times, to give biphenyl in quantitative yield. The postulated mechanism of the decomposition of C (sp2)-Si bond was shown in Scheme 1.

C-05

Hydrogen Production by Decomposition of Cellulose over Metal Catalysts

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Hydrogen production by decomposition of cellulose over metal catalysts was investigated. Ni and Rh catalysts were found to be active for hydrogen production. In the case of Ni catalysts, the rate of H_2 formation was improved by loading of La or Ce on SiO_2 or Na-Mordenite; Ce/SiO_2 and Ce/Na-Mordenite were the most effective supports. In the case of Rh catalysts, only La/Na-Mordenite was effective as support.

C-06

CO_2 Removal by Branched Polyether Membranes

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High molecular weight branched polyethers were prepared by ring opening copolymerization of ethylene

oxide, 2-(2-methoxyethoxy)ethyl glycidyl ether and allylglycidyl ether. The branched polyethers displayed excellent performance for CO_2/N_2 separation, for example CO_2 permeability of 7.7×10^{-8} cm^3(STP)cm/(cm^2 s cmHg) and separation factor of 46 at 308K, because of specific interaction between polyether segment and CO_2. High CO_2 selectivity of the polymer is due to the high solubility selectivity.

C-07

Development of New Copper Recycling System

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New recycling system of copper from metallic wastes by using ammoniacal alkaline solution is being studied. In this system, copper is dissolved as Cu(I) ions in a leaching process, and recovered in an electrowinning process. The electrical consumption in the electrowinning was found to be much smaller than that by a conventional process.

C-08

Design of Recyclable Matrixes from Lignin-Based Polymers

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1,1-Bis(aryl) propane-2-O-aryl ether type lignin-based polymers (lignophenols) were synthesized through the phase-separation system composed of phenols and concentrated acid. Ligno-*p*-cresol, the lignophenol with C1-*p*-cresol, was highly hydroxymethylated (HM) to give network type structures by heating. In order to use it as matrixes of various composites, HM-ligno-*p*-cresol was hybridized with powdery materials such as glass, metal or talc by applying heat and pressure. The resulting composites with glossy surface had high dimensional stability and high solvent resistance. Furthermore, using the switching functionality of ligno-*p*-cresol (nucleophilic attack of C1-cresols to C2), the composites were re-separated into ligno-*p*-cresol fractions and inorganic materials. The physical and recycling properties of composites were controlled by structure of lignophenol matrixes and/or properties of materials such as density, morphology and accessibility for reagents.

C-09

Conversion pattern of lignocellulosics in the phase-separation system

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In the phase-separation reaction system composed of phenol derivatives and concentrated acid, lignin and carbohydrates, which form an interpenetrating polymer network within the cell wall, were separated almost quantitatively into different phases within 30 minutes.

C-10

Conversion of lignocellulosics by phase-separation process -Effect of ultrasonic irradiation-

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Through the phase-separation process, lignocellulosics were converted to the lignin-based polymers (lignophenols) and hydrolyzed carbohydrates. The resulting lignophenols had unique functions, which conventional lignins did not have. The phase-separation reaction composed of phenol derivatives and concentrated acid is included in the process. The reaction is achieved by simple stirring operation for about 60 minutes at ambient temperature in the open system. To heighten the efficiency of the reaction and control the interface reaction between the phenolic and aqueous phases, the ultrasonic energy was added to this reaction system. By the ultrasonic irradiation, the reaction time was shortened and the yields of lignophenols were increased substantially.

C-11

Functions of Lignophenol-Biopolyester Composites

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The lignophenol was synthesized from beech (*Fagus crenata*) protolignin by the phase-separation system. The second functionality control of lignophenol was carried out using the neighboring-group participation reaction. The elongation ratio of lignophenol- biopolyester film was 20 times higher than that of biopolyester film. The lignophenol- biopolyester film had the excellent thermo-stability and biodegradability.

C-12

Dye-sensitized solar cells of porous titanium dioxide with lignophenols

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Recyclable lignin-based polymeric materials (lignophenols) have been synthesized directly from native lignin using the phase-separation system composed of phenols and concentrated acid. Dye-sensitized solar cells of porous titanium dioxide sensitized with lignophenols have showed stable solar energy conversion under irradiating by the direct sunshine. This is the first report of solar energy conversion devices which have been prepared from renewable carbon resources produced by forest.

C-13

Characteristics of Herbaceous Lignocellulosic Resources for Phase-Separation System and Derived Lignophenols

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The phase-separation system could be widely applied to conversions of herbaceous as well as woody lignocellulosic resources. Using this system, lignophenols from any herbs were derived and effectively obtained with lower concentration of acid in comparison with softwoods. Yields of lignophenols from some herb species, which have large amounts of ashes, were low. Properties of herbaceous lignophenols were almost similar in spit of the system condition and the presence of extracts contained in the raw herbs, however they slightly depended on different herb species. Elemental compositions of herbaceous lignocresols had extremely small quantities of nitrogen from protein in lignocellulosics.

C-14

Application of Lignophenol to Positive-type Photoresists

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Recently, Lignophenols have been obtained from Lignin in wood-sources, and now, the establishment of their use as industrial materials is required. We tried to apply them to positive-type photoresists for printing and printed wiring boards [1)], because they have the advantages of (1) good solublity in alkaline water, (2) sensitivity to UV irradiation and (3) resistance to heat. We used them instead of novolac resins in novolac/diazonaphthoquinone (DNQ) system photoresist.

C-15

Peroxidase-catalyzed polymerization of highly phenolic lignin-based macromonomers (lignophenols)

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Peroxidase-catalyzed polymerization of lignophenols such as lignocatechol, lignocresol, and lignophloroglucinol, was carried out in aqueous organic solvents. For lignocatechol and lignocresol, the rate of polymerization was enhanced by the introduction of *p*-cresol and catechol in the lignin side-chains compared with that of original lignin to give the corresponding cross-linked polymers in 87% and 55% yields, respectively. For lignophloroglucinol, the degradation products were obtained. From the IR results, lignocatechol might be polymerized *via* a quinone intermediate and lignocresol though a phenoxyl radical.

C-16

Novel Carbon Membranes derived from Lignin-based Materials

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Novel carbon membranes were prepared by coating thin layers of lignin-based materials derived from lignin by the phase-separation method and then carbonizing under nitrogen atmosphere at 673-1073K. The membrane showed high selectivity of gases. For example, the selectivity of the membrane prepared by carbonizing at 873K was 50, 8, 290 and 87 for CO_2 / N_2, O_2 / N_2, H_2 / CH_4 and CO_2 / CH_4 at 35°C, respectively.

C-17

Production of Crystallized Carbon from Lignocresol for Electromagnetic Shielding

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By 900∞C-carbonization lignocresol (LC) co-loaded with nickel and sodium or calcium produced chars with turbostratic structure carbon (T component) that could afford a practical electromagnetic shielding (EMS) capacity at 50-800 MHz, although the addition of nickel alone did not lead to the formation of crystallized carbon.

C-18

New materials based on renewable resources: Chemically modified highly porous starches and their composites with synthetic monomers

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Starch is the second largest biomass on the Earth. More than 6 MT y^{1} are currently utilised in non-food products including adhesives, textile sizing agents and packaging materials. The high degree of functionality of starch along with its low cost and widespread availability make it a potentially attractive surface-active material. However, the low site availability and its instability in many environments are major limitations to a more widespread application.

C-19

DEVISING OF ALL PLASTIC TYPE DYE-SENSITIZED PHOTOCELLS OF HIGH ENERGY CONVERSION EFFICIENCY

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Plastic-based dye-sensitized photocells were fabricated by electrophoretic TiO_2 deposition technique combined with post chemical treatments of nano-porous TiO_2 layer without use of high-temperature TiO_2 sintering process. The photocell exhibited high energy conversion efficiency of 4-6 % depending on incident light intensity.

C-20

The Efficient Separation of Fuel Oil and Hydrogen Produced in the Dehydrogenative Coupling of Methane

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A method utilizing thermal diffusion effect was developed to achieve more efficient production from methane to fuel oil and hydrogen. A modified thermal diffusion column reactor (TDCR) was designed in order to control both the methane conversion and product yield.

C-21

Monomer Recycling of Vulcanized Silicone Rubbers to Cyclosiloxane Monomers in Solvent or Non-Solvent System. (Study 1): Role of Acid Buffers

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The problem of polymer wastes is now an important issue to be solved for the global protection of petroleum resources from depletion. It must be the primary solution to this problem that polymer wastes are recycled by means of depolymerization to monomers via low-energy processes because monomers can reproduce the same polymers compatible with the original ones.

C-22

Monomer and Filler Recovery from High-Temperature-Vulcanized Silicone Rubbers in Triad Solvent Systems. (Study 2): Combined Effects of Solvent and Base.

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How to solve the problem of polymer wastes at the post-consumer stage is an important issue on the basis of protecting global environment and petroleum resources from depletion. One of primary solutions to the problem is reclamation to monomers. On this concept, silicone polymers the worldwide production of which has reached millions tons annually cannot be an exception to be evaded from recycling because they consume a lot of energy in manufacturing from the resource.

C-23

Recovery of Monomer and Filler from High-Temperature-Vulcanized Silicone Rubbers Using Organic Base as Catalyst (Study 3)

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In the two preceding reports, base-catalyzed depolymerization of HTV-silicone rubbers in solvent and non-solvent systems, in triad solvent systems for the purpose of achieving simultaneous recovery of monomer and filler, are reported.

C-24

Preparation of Fulvic Acid by Pressurized Hot Water Treatment of Weathered Coal

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Fulvic acid becomes more useful than humic acid because of the water-solubility and the phylogenic activations, e.g. antioxidant. Weathered coal contains much humic acid and a little fulvic acid. Therefore, in this work, the production of fulvic acid was examined by hot compressed water treatment of Xinjiang (China) weathered coal or the extracted humic acid form it aiming to substitute the conventional process, the nitric acid oxidation of them.

C-25

Synthesis of a Novel Polyacetal from Disaccharide and Dialdehyde

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A novel polyacetal was synthesized by the reaction of , -D-trehalose with terephthalaldehyde or terephthalaldehyde bis(dimethyl acetal) in the presence of *p*-toluenesulfonic acid as acetalization catalyst. The polycondensation reaction proceeded at 70~120 C under reduced pressure and give products whose

weight-average molecular weight ranged from 2000 to 8500 when measured by GPC. The ^{1}H NMR spectra revealed that the polyacetal is composed of benzylidenetrehalose units.

C-26

Screening of adsorbent for removal H_2S at room temperature

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Hydrogen sulphide is present in natural gas and hydrocarbon feedstocks. H_2S gas maybe removed to less than ppm levels for environmental reason. Oxides of different metals are known to be good adsorbents for desulfurization. In the present study, we synthesized simple oxides, mixed oxides and mixed oxides derieved from hydrotalcites for desulfurization at room temperature.

C-27

Synthesis of Nanoporous Carbon Gel Microspheres as Adsorbents for Energy-Efficient Gas Separation

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Carbon gel microspheres (CGM) were successfully synthesized as adsorbents for energy-efficient gas separation. It was possible to control the nanoporosity of CGM by changing the synthetic procedure. The applicability of CGM to both pressure swing adsorption (PSA) and temperature swing adsorption (TSA) was shown by examining the adsorption behavior of nitrogen and oxygen on CGM.

C-28

Research and Development of SBS (Sugi Bark Sorbent)

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SBS performed equivalent absorbency as conventional polypropylene sorbent in laboratory experiments through the adequate manufacturing process. Experiments conducted in water tanks confirmed that some shape of SBSs could successfully work for recovering oil in small wave and current. SBS was improved into commercial products in 2001. As the next step, we investigated biodegradation treatment methods as a disposal treatment method after use (after adsorbing oil) and confirmed the fact that the oil content was reduced of the amount originally introduced in the bark compost.

C-29

Improved Performance of Oxygen Electrode in Cells by Cobalt Complexes

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We report, for the first time, that cobalt complexes, which reversibly bind and release oxygen, functioned as oxygen carriers or accumulating media for an electrode to enhance the diffusion-limited current for the oxygen reduction. It was found that a larger reduction current was obtained when an electrode was modified with the oxygen carrier based on the rapid release of oxygen from the carrier, which could practically be employed in superior air battery and fuel cell.

C-30

Green Separation on Recovery of Nickel Metal By Reduction Crystallization From the Wastewater of the Electroless Nickel Plating

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Metal recycling from the wastewater and waste, is an efficient approach to recover non-renewable resources. This study focused on the development of nickel metal recovery process from the wastewater of the electroless Ni plating. We have developed the new process, named seeded batch reduction crystallization system, which was applied to the used plating bath, to demonstrate 99% nickel recovery in the optimum operational conditions obtained.

C-31

PRODUCTION OF SUSTAINABLE GASEOUS FUEL FROM ENERGY EFFICIENT CATALYTIC GASIFICATION OF BIOMASS

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Syngas has been produced from the catalytic gasification of cedar wood in a fluidized bed gasifier using air as a gasifying agent. Among the catalyst tested, $Rh/CeO_2/SiO_2$ has shown the best performance. Almost complete carbon conversion to syngas was achieved within 873 to 973 K.

C-32

Non-equilibrium Pulsed Discharge: Definitive Technology for PEMFC-compatible H_2 Generators

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We investigated non-equilibrium direct current pulsed discharge for converting hydrocarbons into hydrogen. This process could be conducted under atmospheric pressure and ambient temperature, so it would be very effective hydrogen generator system.