CYCLODEXTRIN NEWS

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Self-assembled Supramolecular Systems and New Findings in the Treatment of Niemann Pick Disease type C as Shown on the 19th International Cyclodextrin Symposium (ICS19)

The 19th International Cyclodextrin Symposium (ICS19) was held between April 27–30, 2018 in Tokyo. The bibliographic data and keywords of the plenary lectures (2), invited lectures (22), oral presentations (27) and posters (87) can be found in this issue of Cyclodextrin News. The presentations were mostly from Japan (72), followed by France (13), China and Italy (8), Spain (7), Germany (5), Hungary and Thailand (4), Canada (3), Iceland and US (2) while the following countries presented one talk/poster each: Austria, Czech Republic, Denmark, Mexico, Poland, Romania, Singapore and UK.

As it was expected the hot topic was the preparation and characterization of self-assembling supramolecular systems. The polyrotaxanes (CD complexes of polymers) were scientific curiosity when first described independently by Harada and Wenz in 1992. This April at ICS19 various applications have been shown starting from drug delivery systems and diagnostic sensors, through car industry to mobile phones, etc. Meanwhile the synthesis of novel so far not known structures is going on.

Slide-ring materials are polymer networks obtained by crosslinking the polyrotaxanes (Ito, PL1). They have extreme swelling and unusual mechanical performance due to the high mobility of the crosslinks (Fig. 1). Compared to the conventional gels with fixed crosslinks, which show increasing rigidity with increasing crosslinks, the slide-ring gels demonstrate high elasticity and high toughness (fracture energy) at the same time. The slide-ring materials can be used for soft contact lens, paints, rubbers, resins, coating of mobile phone with self-healing property. The extreme softness and stretchability of these slide-ring gels is explained by the observation that fracture energy remains constant at increasing Young's modulus (Liu et al., P77). Calculating the diffusion coefficient (D) of the CD within the slide-ring gels by using molecular dynamics simulation, the results proved that the sliding dynamics depend on friction between rings and chains and the magnitude of chain fluctuation (Yasuda et al., P78). The stress-strain curves show large hysteresis, however, the extended sample go back to the original length thus representing self-recovering property (Maeda et al., P81).

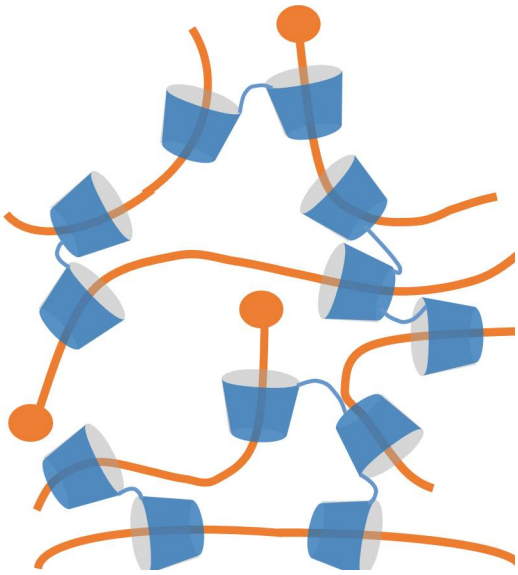

Fig. 1 Slide ring gels (Ito, PL1).

Polyrotaxane glasses (Kato et al., IL21) are CD-based hard materials, in which chain sliding occurs upon stress-induced macroscopic deformations. As the opposite extreme, slide-ring material was prepared by very low host-guest molar ratio (2.5%) to obtain transparent and stretchable hydrogels (Jiang et al., P51). It extended more than 13 times of its length at break. As comparison, the hydrogel with 25% host-gest molar ratio can be stretched only twice of its length.

Smooth and transparent films can be obtained from slide-ring polyrotaxanes prepared by polymerization of 2,3-dimethyl butadiene, styrene, methylacrylate in the presence of RAMEB (Wenz, IL04). These films show self-healing of macroscopic scratches upon heating to 80-100 ^{o}C and can be used in car paints.

Self-assembled hydrogels from chitosan (cationic polymer) and CD-citric acid polymer (anionic polymer) are used as ciprofloxacin delivery systems for the treatment of deep bone infections (Amiel et al., O05). Layer by layer coatings as well as electrospun nanofibers were also produced from the same components (Martel et al., O15).

Polyphosphoesters (hydrophobic decyl units linked by anionic phosphodiester groups) are complexed with HPBCD to obtain pseudopolyrotaxane. ACD was used as stopper group to prevent HPBCD from de-threading. The new polyrotaxane can be efficient in Niemann Pick type C treatment: HPBCD released within lysosomes can capture cholesterol (Egele et al., P11).

Host-guest self-assembly based on β-cyclodextrin copolymers was found applicable for controlling molecular architectures of gene carriers for efficient DNA and siRNA delivery (Wen et al., IL17)

Polypseudorotaxans of both linear and branched polyethylene oxide (PEO), polypropylene oxide (PPO) copolymers (PEO-PPO-PEO) are suitable for bone and cartilage regeneration combined with cell growth support and sustained delivery of active substances (Alvarez-Lorenzo, IL07).

The mechanical properties of polyrotaxanes consisting of BCD and triblock copolymers of polyethylene oxide (PEO, A) and polypropylene oxide (PPO, B) (Fig. 2) can be tuned by chemical modification via introducing trimethylsilyl groups (Uenuma et al., P79).

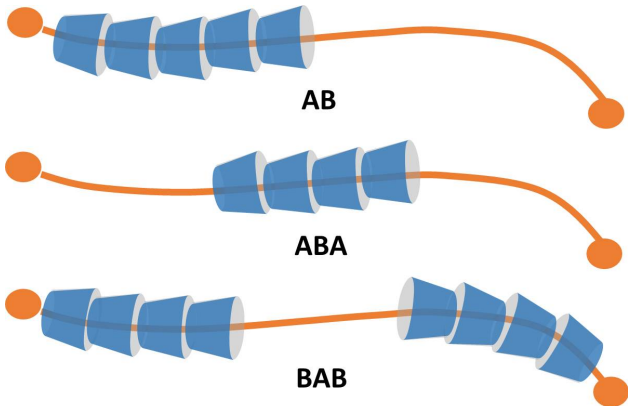

Fig. 2 Scheme of the polyrotaxanes made from PEO-PPO diblock, PEO-PPO-PEO (ABA) and PPO-PEO-PPO (BAB) triblock copolymers (Uenuma et al., P79)

Supra-molecular polymer, supra-molecular necklace on polyethylene glycol chain and hybrid cross-linked hydrogel were prepared based on the interaction between the phenylboronic acid moiety and CD to obtain sugar-responsive release of PEGylated insulin as a model of sugar-responsive system (Egawa et al., O13). It mimics pancreas and seems to be a basis for the development of long-expected **non-invasive insulin administration**. Similar systems can be used as **sugar sensors** (Kobayashi et al., P35, Hattori et al., P52, Ishida et al., P66)

X-shaped block copolymers of PEO and PPO with protonable diamine connector group in the middle (Tetronics) form pseudopolyrotaxanes with native CDs and CD derivatives (Puig-Regall et al., P64) (Fig. 3). The resulting gels can be useful for controlled-release drug (protein) delivery.

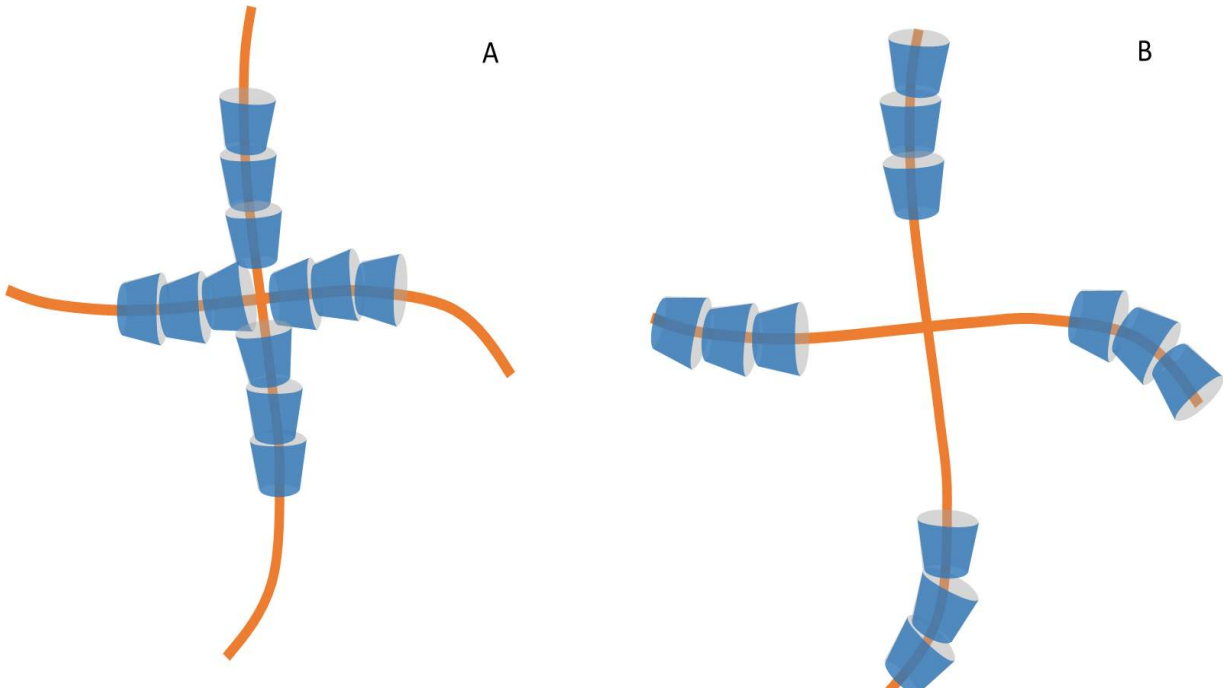

Fig. 3 Schematic representation of polypseudorotaxanes of poloxamines, X-shaped block copolymers of PEO and PPO with a middle diamine connector group (Tetronics) with BCD or HPBCD
A: PPO-PEO arms (PPO in the middle), B: PEO-PPO arms (PEO in the middle)

PEO-PPO-PEO-dithiol was synthesized, the polyrotaxane with BCD and GCD formed, and then the cyclization reaction was carried out to obtain **polycatenane** structure (Morita et al., P80) as shown in Fig. 4.

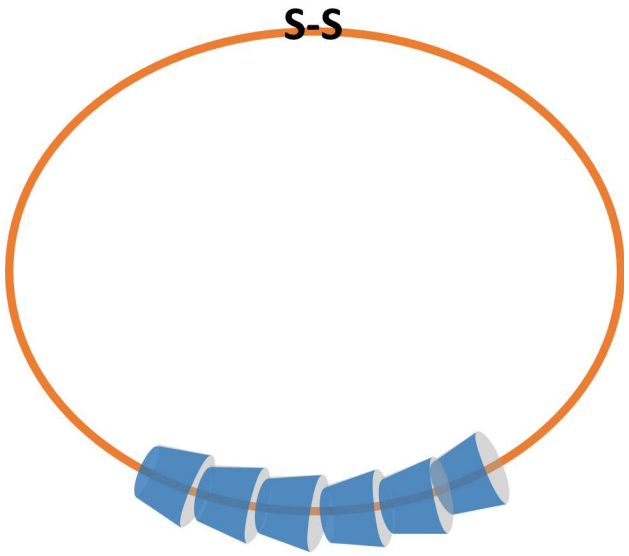

Fig. 4. Scheme of polycatenanes prepared from PEO-PPO-PEO-dithiols by cyclization

CD as active pharmaceutical against Niemann Pick type C disease, the fatal genetic illness resulting in lipid metabolism disorder, was still in the focus (Davidson, PL2; Szente, IL12). The mechanism is not clear, as SBE-BCD, SBE-GCD and HPGCD was found effective for the treatment in animal experiments, although they have low affinity to bind cholesterol. Yamada et al. (P53), however, found that the binding constants for HPBCD and HPGCD are similar at the effective concentration range used for Niemann Pick type C model cells (<2 mM), but the gamma-derivative has low affinity to extract cholesterol from the cell membrane and therefore it is much safer than HPBCD. SBE-CDs have the advantage over HP derivatives that they are not ototoxic (Davidson, PL2).

Polyrotaxanes were developed for more efficient delivery of HPBCD into the cells (Egele et al., P11).

Inclusion ability of CDs with biomembrane components, such as cholesterol and phospholipids was combined with the targeting properties of ligand (fucose, folate, etc.)-appended CDs and used in cancer therapy and against Niemann Pick type C disease (Arima et al., IL13). Lactose-appended CDs provided targeted delivery to the hepatocytes and decreased the cholesterol accumulation in Niemann Pick type C-like HepG2 cells (Maeda et al., P14).

Cyclodextrin News Retrospective

We wrote 10, 20 and 30 years ago

10 years ago, CD News reported on the works presented at the Kyoto Cyclodextrin Symposium held between 8-11 May 2008. The editorial dealt with a specific, interesting segment of the conference, entitled „Effects of CDs in living cells", highlighting the following sub-topics:

- Endocytic internalization of CDs
- Effect on cell membrane
- Effect on cell signaling
- CDs for gene delivery
- CDs as disinfectants

Most of these works were related to folate-modified cyclodextrins, cell membrane modification / cholesterol depletion techniques, photodynamic therapeutic possibilities, inhibition of quorum sensing, etc. These advances were also discussed at the very recent Tokyo Symposium, obviously at a more elaborated stage.

20 years ago, the editorial was a notice on the upcoming conference on the „Challenges for drug delivery and pharmaceutical technology" in honor of Prof. Tsuneji Nagai's 65th birthday held in Tokyo, between 9-11, 1998 (Waseda University) listing his major achievements in the field of cyclodextrin technology. Recently, the participants of the 19th ICS had once again the chance to meet Prof. Nagai in person. His warm words at the banquette ceremony was much appreciated by the cyclodextrin community gathered again in Tokyo.

30 years ago, Cyclodextrin News editorial reported on the limits of cyclodextrin utilization in drug products. Most of the issues enumerated are barely historical, however, a very creative figure depicting the CD [WO]MAN is definitely worth sharing again. The picture shows how cyclodextrins may help overcoming some drug-related problems from head to foot.

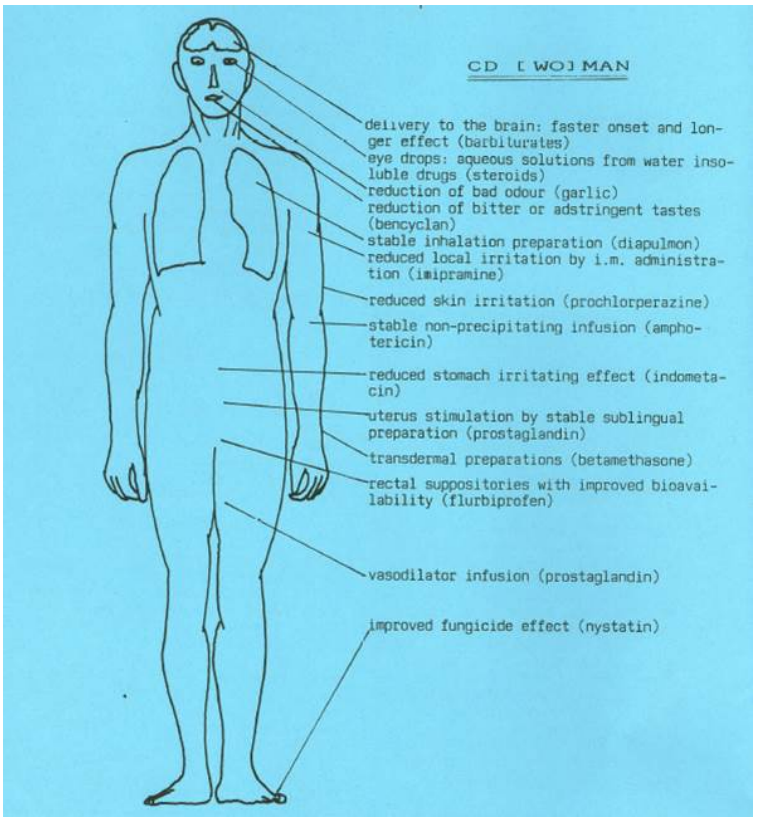

Fig. 5. The CD [WO]MAN (Szejtli's original drawing)

Bibliography & Keywords of the Presentations at the 19th International Cyclodextrin Symposium

PL01 Ito, K.

Slide-ring materials: molecular design strategy for SHINAYAKA polymers

Polymer network, Elastomer, Young's modulus, Entropic mobility, Fracture energy, Soft contact lens, paints, rubbers, resins, Soft actuator, Coating on the mobile phone

PL2 Davidson, C.D.

Long term efficacy of different cyclodextrins for the treatment of Niemann-Pick type C disease

Sulfobutylether derivatives, Second generation CDs with low ototoxicity, Long term mouse studies, Lifespan

IL01 Kitagishi, H.

Porphyrins complexed with per-*O*-methyl-β-cyclodextrin derivatives

Biomimetic chemistry of heme proteins, Myoglobin model, HemoCD, Octaarginine, Cell-penetrating peptide, Removal of endogenous CO

IL02 Zhang, Y. (Liu, Y.)

Stimuli-responsive behaviours of cyclodextrin-based supramolecular assembly

Photoswitchable conformational changes, Singlet oxygen generation, Stable (pseudo)rotaxanes, Controlled drug release

IL03 Harada, A.; Takashima, Y.; Hashidzume, A.; Yamaguchi, H.

Supramolecular materials formed by cyclodextrin-guest interactions

Host gel containing ACD or BCD, Guest gel containing azobenzene or adamantine, Self-healing properties, Light responsive system, Artificial muscle

IL04 Wenz, G.; Becker-Williger, C.; Kali, G.

Self-healing car paints from cyclodextrin polyrotaxanes

Slide-ring gel, Cellular phone, Block-copolyrotaxanes

IL05 Motoyama, K.; Yamashita, Y.; Tanaka, N.; Higashi, T.; Arima, H.

Involvement of mitophagy-mediated cell death for antitumor activity of folate-appended methyl-β-cyclodextrins

Removal of damaged mitochondria, Intracellular ROS generation, KB-cell-xenografted mice, Lowered ATP production, Antitumor activity

IL06 Terao, K.

A new generation of nutra-ceuticals and cosme-ceuticals complexing lipophilic bioactives with γ-cyclodextrin

CoQ10 formulation, Enhancing Cmax and AUC, Prolonging t1/2, Sodium taurocholate, Curcumin, Tocotrienol

IL07 Alvarez-Lorenzo, C.

Cyclodextrins as multi-task components of scaffolds

Regenerative medicine, Composite cement, Calcification, Polypseudorotaxanes, Poloxamer, Poloxamine, Bone and cartilage regeneration, Electrospun CD nanofilters, Hamamelitannin (quorum sensing inhibitor), Acrylamidomethyl GCD

IL08 Ikeda, T.; Morohoshi, T.; Ito, S.; Kato, N.

Inhibitory effects by cyclodextrin on quorum sensing in Gram-negative bacteria

N-acyl-L-homoserine lactone (AHL), AHL-trapping by CDs, Alkylamino CDs, Inhibition of biofilm formation

IL09 Viernstein, H.; Wolschann, P.

Formulation of nabilone-cyclodextrin complexes

RAMEB, Fast disintegrating tablets

IL10 Ikuta, N.; Rimbach, G.; Matsugo, S.; Terao, K.

Studies on R(+)-α-lipoic acid-cyclodextrin complex and its applications

Clinical pharmacokinetic study, Regulation of energy metabolism, Neutraceutical

IL11 Fourmentin, S.; Landy, D.

Encapsulation of volatiles in cyclodextrins: state of art, recommendations and perspectives

Essential oils, Methods for characterization of CD/volatiles inclusion complexes

IL12 Szente, L.

Cyclodextrins as active pharmaceuticals and diagnostic agents

Therapeutic use of "empty" CDs, Selective removal of a neuromuscular blocking agent, HPBCD, Niemann Pick type C disease, Focal segmental glomerulosis, Alport syndrome, Diabetic nephropathy, Diabetes type 2, Sensor, DNA quenching

IL13 Arima, H.; Motoyama, K.; Higashi, T.

Cyclodextrins as drug targeting vehicles and active pharmaceutical ingredients

Folate-appended BCD, Pegylated BCD, Adamantane-appended proteins, Fucose-appended PAMAM dendrimer/ACD conjugates, Folate-appended PAMAM dendrimer/ACD conjugates, Niemann Pick type C disease

IL14 Sollogoub, M.

Selective functionalizations of cyclodextrins for bio-inspired applications

Site-selective functionalization, Regioselective debenzylation, Poly-hetero-functionalized CDs

IL15 Trotta

New redox responsive cyclodextrin nanosponges

Nanocarrier, Redox stimulus, Doxorubicin

L16 Mazzaglia, A.

Nanocontructs based on cyclodextrin: design, advances in combined drug delivery and theranostic approaches

Stimuli-responsive multifunctional nanoconstructs, Electrical release of neurotransmitters, Antiviral delivery

IL 17 Wen, Y.; Zhu, J.; Song, X.; Li, J.

Host-guest self-assembly based on β-cyclodextrin copolymers for controlling molecular architectures of gene carriers for efficient DNA and siRNA delivery

Poly(2-dimethylaminoethyl methacrylate) linked to BCD core, Adamantyl end-capped poly(2-methacryloyloxyethyl phosphorylcholine), Polyplex nanoparticles

IL18 Loftsson, T.

Cyclodextrin nanoparticles for topical drug delivery to the posterior segment of the eye: in vitro studies and clinical evaluations

Ocular bioavailability, Lipophilic membrane barrier, Dexamethasone, Dorzolamide, Cyclosporin, Increased drug contact time with the eye surface, Phase I/II studies in humans, Diabetic macular edema

IL19 Jeschke, I.

Use of cyclodextrins as controlled release technique for insect repellent formulations

Delayed release, Evaporative trials

IL21 Kato, K., Nemoto, K., Mayumi, K., Yokoyama, H., Ito, K.

Stretch-induced intramolecular phase separation of cyclodextrin - based polyrotaxane

Viscoelastic measurements, Arrhenius-like glass transition, Chain transfer, Aging

IL22 Easton,, C.

Construction of cyclodextrin based functional devices for solution and solid state applications

Molecular rachets, Motors, Gates, Muscles, Catalysts, Hermaphrodite building blocks

O01 Yang, X., Wang, R.

The influence of β-cyclodextrin and cucurbit[7]uril on the developmental toxicity of anabasine

Zebrafish embryo

O02 Suzuki, R., Murata, I., Inoue, Y., Nomura, H., Isshiki, Y., Kondo, S., Kanamoto, I.

Evaluation of antimicrobial activity of hinokitiol with cyclodextrins

Co-grinding, MIC value, Pseudomonas aeruginosa, Bacillus subtilis, Staphylococcus aureus, Esherichia coli

O04 Swiech, O., Majdecki, M., Krzak, A., Stepkowski, T.M., Kruszewski, M., Bilewicz, R.

New conjugate of cyclodextrin and folic acid in pH-sensitive, targeted therapy with anthracycline drugs

Doxorubicin, Daunorubicin, Targeting substituents, Folic acid, Triazole linker

O05 Amiel, A.G., Palomino, C., Lopez, M., Maton, M., Cazaux, F., Chai, F., Neut, C., Foligne, B., Martel, B., Blanchemain, N.

Ciprofloxacin-loaded sponges (Chitosan/Cyclodextrin polymer) for treatment of bone infections

Polyelectrolyte complex, Thermal treatment, Initial burst effect

O06 Ezawa, T., Inoue, Y., Murata, I., Takao, K., Sugita, Y., Kanamoto, I.

Change in the dissolution property of piperine by co-grinding with α-cyclodextrin

Lipid metabolism, Antioxidant effect, Photoisomerization

O07 Caldera, F., Argenziano, M., Brunella, V., Trotta, F., Cavalli, R.

Molecularly imprinted cyclodextrin nanosponges as innovative nanoformulation for the treatment of Parkinson's disease

Carbonyldiimidazole, Crosslinking BCD, Controlled release, Bioavailability

O08 Sonnendecker, C., Zimmermann, W.

Engineering cyclodextrin glucanotransferases to form large-ring cyclodextrins

Product spectrum, Semi random mutagenesis, CD9, CD17

O09 Przybylski, C., Benito, J.M., Ortiz-Mellet, C., Garcia-Fernandez, J.M., Blin, F., Mamad-Hemouch, H., Ramoul, H., Jarroux, N., Gervaise, C., Bonnet, V.

Mass spectrometry as a Swiss knife for the structural deciphering of cyclodextrin derivatives: from single molecule to macromolecular assemblies

Polycationic CDs, Polyrotaxanes, Nanotubes

O10 Duan, N., Ye, L., Zhang, A., Feng, Z.

Characterization of polyrotaxanes based on inclusion complexes of β-CDs with ferrocene containing ATRP initiators

Atom transfer radical polymerization, End-capping, Intermolecular hydrogen bonds, N-isopropylacrylamide

O11 Champagne, P.L., Ester, D., Williams, V.E., Ling, C.C.

New family of cyclodextrin thermotropic liquid crystals self-assembly and its potential as ion transport materials

Fuel cells, Lithium-ion battery

O12Zhang, P., Leriche-Dune, E., Klassen, J., Ling, C.C.

SulfoPEGylated cyclodextrins, a novel family of structurally well-defined excipients

Polyanionic CDs, SulfoPEG chains of defined length

O13 Egawa, Y., Miki, R., Seki, T.

Machines based on the combination of phenylboronic acid and cyclodextrins

Insulin release, Supra-molecular polymer, Supra-molecular necklace, Hybrid cross-linked hydrogel, PEGylated insulin, Accelerated release, D-glucose

O14 Puskás, I., Láng, B., Fenyvesi, É., Szente, L.

Properties of cyclodextrin polymer layers adsorbed on polystyrene latex nanoparticles

Dispersion colloids, Uncharged ACD, BCD and GCD polymers, Quaternary amino BCD polymer, Carboxymethyl BCD polymer, Thickness of the adsorbed layer, Zeta potential

O15 Martel, B., Tabary, N., Degoutin, S., Kersani, D., Lopez, M., Mogrovejo, A., Durand, C.P., Auzit, A., Cazaux, F., Janus, L., Neut, C., Blanchemain, N.

Multi-shaped materials designed from cyclodextrin-based polyelectrolyte complexes

Anionic and cationic CD polymers, Chitosan, Prolonged antimicrobial activity, Nanofibers, Hydrogels

O16 Tsuchiya, R., Mori, T., Doi, M., Nagatani, N., Tanaka, T:

Solubilization of ultraviolet absorbers by cyclodextrins and application for cosmetics

HPBCD, Ferrulic acid, Sunscreens

O17 Kersani, D., Lopez, M., Mougin, J., Degoutin, S., Tabary, N., Cazaux, F., Hue, B., Maton, M., Chai, F., Sobocinski, J., Blanchemain, N., Martel, B.

Drug-eluting stents coated by simvastatin-loaded poly-cyclodextrin nanofibers: in vitro release study and in vivo preliminary evaluation

Cardiovascular diseases, Release profiles, Rabbit model

O18 Casaletto, P.M., Privitera, A., Testa, M.L., Mazzaglia, A., Zagami, R.

β-cyclodextrin for the preventive conservation of cultural heritage

Benzotriazole, Corrosion inhibitor, Surface of metallic and stone substrates, Antimicrobials

O19 Bonnet, V., Sevin, E., Nolay, F., Djedaini-Pilard, F., El Kirat, K., Morandat, S., Blanchet, V., Gosselet, F., Michel, J., Tilloy, L.

Preparation of vesicles based on amphiphilic cyclodextrin to release slowly loaded atanazavir and improve uptake in the Blood-Brain Barrier cells

Phospholipid, Lipophosphoramidyl-BCD, Anti-HIV drug

O20 Monflier, E.

Transition metal catalysis in cyclodextrin-based unconventional reaction media

Supramolecular hydrogels, Low melting mixtures, N-alkylpyridinium derivatives, PEG, Dimethyl urea

O21 Wang, J. Harrison, M.

Removal of organic contaminants from water using beta-cyclodextrin-triazine polymer

Bisphenol-A, Water treatment

O22 Ponchel, A., Wyrwalski, F., Machut, C., Bleta, R., Monflier, E.

Uses of cyclodextrins for the preparation of environmental oxidation catalysts: from dispersing agents to supramolecular templates

Cobalt salt, Formaldehyde, Mesoporous titania, Photocatalytic activity, Phenoxyacetic acid

O23 Zhang, Y.M.; Yu, L.; Liu, Y.

Cyclodextrin-based bioactive nanosupramolecular assemblies

Tyramine-modified BCD, Deoxycholic acid, Rat blood and urine, Bile-acid-related diseases

O24 Yamamoto, T.; Yoshimoto, C.; Tanaka, K.; Noothalapathi, H.; Yoshikiyo, K.; Miyagawa, A.; Yamamura, H.

A Raman microspectroscopic study on the destruction process of liposome membranes by hepta-6-benzylamino-β-cyclodextrin

Phosphatidylcholine, Mimic for Polymixin B

O25 Suzuki, N.; Kinoshita, M.; Watanabe, S.; Miyabe, K.

Chiral separation of phenoxypropionic acid with cyclodextrin: kinetic study by moment analysis based on affinity capillary electrophoresis

Moment analysis, First absolute moment, Second central moment

O26 Pineiro, Á.; Garcia.Fandino, R.; Carballosa, A.; Paz, M.; Garrido, P.F.

Computational molecular dynamics simulations of cyclodextrin systems: a must

Number and specific location of substituents, Modified CDs

O27 Garcia Fandino, R.; Pineiro, Á.; Pérez, M.J.; Pan, A.

Computational simulation, virtual/augmented reality and 3D-printing for cyclodextrin visualization and research closing remarks

Interaction of CDs with other CDs and guests, 3D-printable model

P01 Khummanee, N.; Rudeekulthamrong, P.; Kaulpiboon, J.

Cyclodextrin glycosyltransferase-catalyzed synthesis of pinoresinol-α-D-glucoside with antioxidant and anti-inflammatory activities

Enzymatic synthesis, BCD as glucosyl donor

P02 Kaulpiboon, J.; Rudeekulthamrong, P.

Biosynthesis of methyl glucoside and its potential role in antibacterial activity

Cyclodextrin glycosyltransferase, Transglycosylation, Non-ionic surfactants, Inhibition of bacterial growth

P03 Najera, A.R.H.; Sanchez Garduno, D.; Hernandez, .M., Gomez Balderas, R.; Rojas Hernandez, A.

Speciation of indomethacin-cyclodextrins inclusion complex in water

Nonsteroidal anti-inflammatory drug, BCD, HPBCD

P04 Ataboongwonse, C.; Sultana, A.; Cken, N.T.V.A.; Ariyanto, H.D.; Yoshii, H.

Formation of rare sugar powder with vacuum drying using additives

Cyclic cluster dextrin, ACD, BCD, GCD

P05 Higashi, T.; Hirotsu, T.; Sato, N.; Kogo, T.; Motoyama, K.; Arima, H:

Efficient anticancer drug delivery for pancreatic cancer treatment utilizing self-assembly pegylated bromelain

Pancreatic cancer, Improved blood retention, Multi-substituted PEGylated BCD, Doxorubicin

P06 Mohammed, A.F.A.; Ohyama, A.; Higashi, T.; Motoyama, K.; Arima, H.

Induction of RNAi using a siRNA complex with folate PEG-appended polyamidoamine dendrimer (G3) conjugates with glucuronylglucosyl-β-cyclodextrin as novel tumor cell targeted siRNA carriers

Cytotoxicity, FITC-siRNA, Human renal adenocarcinoma cell

P07 Praphanwittaya, P.; Saokami. P.; Loftsson, T.

Effect of hydrophilic polymers on cyclodextrin complexation and solubilization of kinase inhibitors

Binary drug/GCD complex, Ternary drug/GCD/polymer complex, Phase-solubility profiles, Cediranib, Pazopanib, Regorafenib, Hexadimethrine bromide, Nano-sized aggregates

P08 Muini, R.; Areoso, C.; Alvarez-Lorenzo, C.; Lorenzo, S.A.; Carro, A.M.; Concheiro, A.

Cyclodextrin-grafted filter paper for selective removal of anti-inflammatory drugs from aqueous environment

N-hydroxymethylacrylamide, Ciprofloxacin, Diclofenac, Ionic interaction with cellulose

P09 Yoshikiyo, K.; Narumiya, Y.; Fukushima, S.; Shimizu, H.; Yamamoto, T.

Absorption property of powdery inclusion complex of perilla oil with γ-cyclodextrin in rat intestine

Blood glucose level, Biomarkers for liver health, Plasma fatty acid, Enhanced bioavailability, Eicosapentaenic acid

P10 Suzuki, M.; Takeoka, Y.; Rikukawa, M.; Yoshizawa-Fujita, M.

Addition effects of cyclodextrin in ionic liquid electrolytes (III) -Influence of CD content on ionic conductivity

Bis(trifluoromethylsulfonyl)amide, Li-ion batteries, Acetylated BCD, Solidified composites

P11 Egele, K.; Samaddar, S.; Collins, C.J.; Thompson, D.H.; Wenz, G.

Synthesis of a new polyalkylenphosphate-based polyrotaxane and evaluation of its potential in treatment of Niemann-Pick type C disease

Polyphosphoesters, HPBCD, Hydrophobic decyl units, ACD stopper groups

P12 Kučáková, K.; Dolensky, B.

NMR study of cholesterol complex with heptakis(2,3,6-tri-O-methyl)-β-cyclodextrin

Intermolecular interactions, Hydrocarbon tail, 2D COSY, ROESY, HSQC, HMBC

P13 Uekaji, Y.; Terao, K.

Preparation of reduced form of coenzyme Q10 by complexation with γ-cyclodextrin

Ubiquinol, Ubiquinone, Antioxidant effect, Sodium hydrosulfite, Conversion efficiency

P14 Maeda, Y.; Nishiyama, R.; Motoyama, K.; Higashi, T.; Yamada, Y.; Ishitsuka, Y.; Kondo, Y.; Irie, T.; Era, T.; Arima, H.

Evaluation of lactose-appended β-cyclodextrin as a novel therapeutic agent for Niemann-Pick type C disease

Hepatosplenomegaly, Cholesterol, Asialoglycoprotein receptor-mediated endocytosis, Targeting to hepatocytes

P15 Nguyen, V.A.T.; Yoshii, H.

Formation inclusion complex of cyclodextrin and allyl sulfide and their stability

Flavor, Spray drying, ACD, BCD, GCD, Release rate

P16 Ariyanto, H.D.; Yoshii, H.

The impact of moisture absorption on the release behavior of 1-methylcyclopropene/ α-cyclodextrin inclusion complexes

Ethylene inhibitor agent, Packaging, Humidity, Aggregation

P17 Ishida, Y.; Nakata, D.; Okamoto, H.; Yoshikawa, Y.; Terao, K.

Development of ursolic acid contained ku-ding-tea leaf extract-γ-cyclodextrin complex with high bioavailability

Traditional home medicine, Anti-metabolic syndrome, Locomotive syndrome, Hydrosolubility, Bioavailability, GCD

P18 Furune, T.; Ishida, Y.; Terao, K.

A thermal stability comparison of α-cyclodextrin and the other carbohydrates

Hydroxymethylfurfural, Fructose, Maillard reactivity

P19 Tsuchie, R.; Shimozato, M.; Hamasaki, K.

Cyclodextrin host-guest chemistry triggers folding of modified short peptide having double naphthalene arms

Adamantanol, Excimer emission

P20 Okamoto, H.; Ino, S.; Nihei, N.; Ueno, C.; Ishida Y.; Itoi, A.; Ikuta, N.; Terao, K.; Yoshikawa, Y.; Sakamoto, N.

Pungent component in daikon stabilized by α-cyclodextrin suppressed obesity in mice

4-Methylthio-3-butenyl isothiocyanate, Anti-obesity effect, ACD, Adipose cell, Accumulation of lipid in liver, Plasma triglyceride

P21 Sohajda, T.; Puskás, I.; Szente, L.

Utility of cyclodextrins in protein formulations

Aggregation, Folding, Adsorption on the container surface, Stability, Artificial chaperons, Lysozyme, Oval albumin, Casein, Insulin, Monoclonal antibodies

P22 Saito, R.; Matsumoto, M.

Inclusion compound of cyclodextrin modified having poly(acrylic acid) arms and poly(amideimide) for battery material

Lithium ion battery, Binder for the electrode, Dispersion, Smoluchowski's theory

P23 Fenyvesi, É.; Molnár, M., Tar, A.; Gulyás, A.; Puskás, I.; Szente, L.

Effect of triclosan/cyclodextrin complexes on bacterial communication

N-acyl-L-homoserine lactone, HPBCD, RAMEB, SBE-BCD, quaternary amino CDs, Polymers, Aliivibrio fischeri, Synergistic effect

P24 Ogawa, N.; Hida, K.; Aoki, C.; Kumagai, K.; Tanaka, S.; Uwekaji, Y., Ishida, Y.; Ikuta, N.; Takahashi, C.;Kawashima, Y.; Terao, K.;Yamamoto, H:

Evaluation of isoprenoid compounds-γ-cyclodextrin inclusion complexes and inclusion complex crystals

Coenzyme Q10, Geraniol, Geranyl formate, Farnesol, Geranylgeraniol, Solanesol, Crystallinity

P25 Anraku, M.; Ifuku, S.; Iohara, D.; Uekama, K:;Hirayama, F.

Surface-deacetylated chitin nanofibers reinforced with a sulfobutyl ether β-cyclodextrin gel loaded with prednisolone as potential therapy for inflammatory bowel disease

Collitis model mice, Oral administration to rats, Controlled release

P26 Iohara, D.; Anraku, M.; Uekama, K.; Hirayama, F.

Crystallization behavior of amorphous drug complex in the presence of two different cyclodextrins

Limaprost, Kneading, Grinding

P27 Furuishi, T.; Terada, R.; Gunji, M.; Fukuzawa, K.

Ternary system of mirtazapine with sulfobutylether-β-cyclodextrin and propylene glycol alginate

Serotonergic antidepressant, Ternary system

P28 Tominaga, T.; Yuan, D.Q.; Fukudome, M.; Koga, K:

Trial of the synthesis of host molecules with the combined characteristics of both cyclodexrins and cucurbiturils

2-Imidazolidinone moiety, Twisted Intramolecular Charge Transfer, Dual fluorescence emission, ACD

P29 Okubo, M., Iohara, D.; Anraku, M., Uekama, K.; Hirayama, F.

Preparation of thermoresponsive sangelose®/cyclodextrin injectable gel for a sustained release system of proteins

Hydroxypropylmethyl cellulose stearoxy ether, Temperature-dependent change in viscosity, Indocyanine green, Insulin, Sustained release system for proteins

P30 Tabary, N.; Vandendrisse, P.; Lyskawa, J.; Blanchemain, N.; Martel, B.

Functionalization of ePTFE vascular graft via a polydopamine/polyethyleneimine/polycyclodextrin platform for prolonged release of antibiotics

Citric acid-cyclodextrin polymer, Drug release platform, Ciprofloxacin, Prolonged antimicrobial activity

P31 Muankaew, C.; Sahariah, P.; Jansook, P.; Loftsson, T.

Cationic crosslinked γ-cyclodextrin: characterizations, complex formation and effect of cationic polymer on the antimicrobial activity

Hexadimethrine bromide, Ethylene glycol diglycidyl ether, Acetazolamide

P32 Garcia-Fernandez, M.J.; Tabary, N.; Willart, J.F.; Chai, F.; Blanchemain, N.; Flament, M.; Martel, B.

Cyclodextrin polymer as a multifunctional excipient in tablet formulations

Citric acid-crosslinked CD polymer, Water soluble, Water insoluble, Direct compression tablets, Toxicity study on rats, Ibuprofen, Simvastatin, Piroxicam, Kneading

P33 Kuwabara, T., Hosokawa, Y.; Katsumata, M., Hu, J., Ide, T., Yokoyama, S.

Synthesis and molecular recognition of β-cyclodextrin bearing a coumarin

Molecule-sensing system, 7-Diethylaminocoumarin, 6-Deoxy-6-amino-BCD, 1-Adamantanol, Guest-induced spectral variations

P34 Yasunaga, S.; Wei, X.; Yang, C.; Fukudome, M., Yuan, D.Q.

Tetra- and hexamannoepoxides of γ-cyclodextrin: one-pot synthesis and catalysis in the photocyclodimerization of 2-anthracenecarboxylic acid

3,3-Benzophenonebis(sulfonylimidazole), Anthracene carboxylic acid, Catalysis

P35 Kobayashi , Y.; Egawa, Y.; Miki, R.; Seki, T.

One-pot preparation of slide-ring gels using a vinyl-modified cyclodextrin

4-Vinylphenylboronic acid, Sugar-sensing moiety, Swelling – contraction responses, Fructose

P36 Mahalapbutr, P.; Nutho, B.; Wolschann, P.; Rungrotmongkol, T.

Molecular insights into inclusion complexes of mansonone e and h enantiomers with various β-cyclodextrins

Methylated and hydroxypropylated CDs, Intermolecular hydrogen-bond formation

P37 Mitsumori, A.; Narumi, S., Mitomo, S.; Negishi, Y.; Murata, I., Inoue, Y.; Kanamoto, I.

Quantitative analysis of cyclodextrins by HPLC-ECD

Ion-exchange resin of core-shell type filler, Styrene/divinylbenzene polymer modified by tetramethyldiaminohexane

P38 Morita, T.; Fujiyama, H.; Hamasaki, K.

HPβCD reversibly regulate folding of double naphthalene modified short peptide

Dimer of naphthalene unit, Excimer fluorescence, 1-Adamantanol

P39 Fukudome, M.; Fukuda, K.; Yuan, D.Q.

Synthesis and structure of rotaxanes constructed of α-cyclodextrin derivatives with distorted cavity

Mono-altro-BCD, €-4,4'-diaminostylbene, 2,4,6-trinitrobenzene-1-sulfonate

P40 Takeda, H.;Takada, Y.; Nagai, D.; Yoneyama, M.; Uchara, H.; Yamanobe, T.; Takahashi, K.

Evaluation of physical properties of polylactic acid / modified cyclodextrin complex

Mixed films, TRIMEB as plasticizer, Stretching temperature

P41 Aramă, C.; Stanescu, M.; Nedelcu, A.; Constantinescu, C.

Electrophoretic and spectrometric characterization of the competitive interactions of drug racemates and amino acid based chiral ionic liquids with cyclodextrins

Ondansetron, Ofloxacin, Mianserin, Polarity of BCD substituents

P42 Moufawad, T.; Moura, L.; Tilloy, S.; Ferreire, M.; Bricout, H.; Monflier, E.; Landy, D.; Costa Gomes, M.F.; Fourmentin, S.

Deep eutectic solvents incorporating cyclodextrins: promising candidates for the solubilisation of organic compounds

Choline chloride, Urea, Eutectic mixture, RAMEB, CRYSMEB, tert-Butylcyclohexane, Azo dye, Methyl orange

P43 Sasaki, T.; Sakamoto, T.; Otsuka, M.

Evaluation of α-cyclodextrin hexahydrate crystal by high accuracy terahertz spectroscopy

Polyethylene, Microcrystal powder

P44 Oda, Y.; Nakagawa, J.; Watanabe, M.; Yamanoi, T.

Synthesis of β-cyclodextrin derivatives multivalently conjugated with carbohydrate moieties through click chemistry reaction

Beta-arbutin, p-Hydroxyphenyl beta-D-glucopyranoside, Azide-alkyne Huisgen cycloaddition, Mannopyranose, 2-Acetamido-2-deoxy-glucopyranose, Hybrid

P45 Kimura, M.; Honda, C.; Hamaguchi, R.; Kuroda, Y.; Tanimoto, T.; Terao, K.

Evaluation of methylation degree of the commercial methylated β-cyclodextrins

TRIMEB, DIMEB, RAMEB, methyl BCD, Nephrotoxicity, Hexakis(2,6-di-O-methyl)-(2,3,6-tri-O-methyl) BCD

P46 Ishimoto, A.; Ueda, K.; Higashi, K.; Sasako, H.; Koyama, K.; Moribe, K.

Preparation of cholesteryl oleate/γ-cyclodextrin nanoparticles by solvent diffusion method

Particle size distribution, Nanosuspension, Core-shell structure

P47 Vlasova, A.; Mendes, C.; Howe, O.; McNamara, M.

Folate receptor targeted drug delivery system based on cyclodextrins for cancer therapy

Methotrexate, Pemetrexed, Cellular uptake of folic acid, Cytotoxicity

P48 Takahashi, K.; Hamamura, K.; Sei, Y.

Unique nucleic magnetic resonance behavior of γ-cyclodextrin in non-aqueous solutions

Pyridine, DMF, DMSO, Intermolecular multibonds

P49 Takahashi, K.; Sasaki, M.; Sato, T.; Yamada, K.; Yajima, H.

The effect of cyclodextrins on precipitation of the ingredient for Japanese traditional rouge, "Sasa-iro-beni"

ACD, BCD, GCD, HPBCD, Crimson pigment, Carthamin

P50 Schwarz, D.H.; Wenz, G.

Cyclodextrin-hyaluronic acid conjugates as side-specific drug carriers

Preventing uncontrolled uptake of the CDs in the human body, Testosterone, Hydrocortisone

P51 Jiang, L.; Liu, C.; Mayumi, K.; Kato, K.; Yokoyama, H.; Ito, K.

A highly stretchable and reversible slide-ring gel with wide cross-links slidable range

PEG-based polyrotaxanes, Host-guest stoichiometry, One-pot transglutaminase enzymatic end-capping

P52 Hattori, T.; Nonaka, K.; Fujiwara, S.; Tsuchido, Y.; Hashimoto, T.; Hayashita, T.

Design and supramolecular chirality function of cyclodextrin complexes with ditopic type probe possessing phenylboronic acid and dipicolylamine recognition sites

Chemical sensors, Monophosphate, Triphosphate

P53 Yamada, Y.; Ishitsuka, Y.; Nakahara, S.; Kondo, Y.; Takeo, T.; Nakagata, N.; Era, T.; Higashi, T.; Motoyama, K.; Arima, H., (…), Irie, T.

Pre-clinical efficacy and safety of HP-γ-CD as a novel therapeutic drug candidate for Niemann-Pick disease type C and its mechanistic analyses

Pre-clinical study on mice, Solubilization of cholesterol at low HPCD concentration, Cytotoxicity

P54 Soma, S.; Suzuki, T.; Fujiwara, S.; Hashimoto, T.; Hayashita, T:

Development of dipicolylamine fluorescent probe/cyclodextrin complex gel for recognition of phosphoric acid derivatives

Coumarin fluorophore, Butylphenyl unit, Ion recognition, Fluorescence enhancement for Zn- and Cd-ions, Fluorescence quenching for Cu-, Ni-, Co-ions

P55 Ikeda, H.; Terao, K.; Nakata, D.; Ishida, Y., Uekaji, Y.; Takagi, S.

Structures of inclusion complexes of leaf alcohol or its analogs with α-cyclodextrin

Molecular mechanics calculation, H-bonds

P56 Menuel, S.; Monflier, E.; Hapiot, F.

From selective modification to catalysis in solid phase: Interest of mechanochemical activation in cyclodextrins' chemistry

Ball-milling, Gold nanoparticles, Rhodium-catalyzed hydroformylation of aromatic-substituted alkenes

P57 Feng, X.

3D Covalent organic frameworks constructed by cyclodextrin

Gas storage, Catalysis, Optoelectronics, Energy storage, CD as building block

P58 Matsuda, N.; Ishimaru, Y.

Rotational control of glucose unit in γ-cyclodextrin macrocycle

p-Xylene linker, Dimer

P59 Tsukada, K., Ishimaru, Y.

Reactivity of glucose unit in α-cyclodextrin macrocycle

p-Xylene linker, Dimer

P60 Mao, Q.; Kitagishi, H.

Optimization of synthesis of per-*O*-methylated β-cyclodextin dimer having a pyridine linker

2,6-di-O-methyl BCD, 3,5-dichloromethylpyridine, HemoCD, Artificial oxygen carrier, Antidote for cyanide anion

P61 Sawaguchi, K.; Takayama, Y.; Nasuno, E.; Iimura, K. Kato, N.

Inhibitory effects of cyclodextrin on biofilm growth using hydrogel flow cell

N-acylhomoserine lactone, Pseudomonas aeruginosa, Methyl BCD

P62 Sakai, R.; Nasuno, E.; Ueno, C., Iimura, K., Terao, K., Kato, N:

Synergy effects of manuka honey and α-cyclodextrin on antibacterial activity against Gram-negative bacteria

Methylglyoxal, Serratia marcensens, Live cell density

P63 Kojima, S.; Mizuta, Y.; Sugita, K., Tsuchido, Y.; Hashimoto, T., Hayashita, T.

Spacer effect of pyrene phenylboronic acid fluorescent probe/CD complexes for saccharides recognition in water

Fluorescent moiety, Fructose, glucose

P64 Puig-Rigall, J., Stead, I.; Serra Gomezí, R.; Grillo, I.; Dreiss, C.D.; González-Gaitano, G.

Pseudopolyrotaxanes of direct and reverse poloxamines: a kinetic approach

X-shaped block copolymers, PEO, PPO, Tetronic, Native CDs, CD derivatives, Mixed polyrotaxanes

P65 Kasahara, C.; Kojima, S.; Mizuta, Y.; Sugita, K.; Tsuchido, Y., Jashimoto, T.; Hayashita, T.

Evaluation of fluorescent probes possessing halogen for saccharides recognition in water

Phenylboronic acid, Fluorine, Chlorine, GCD, Glucose, Galactose, Fructose

P66 Ishida, M.; Tsuchido, Y.; Fujiwara, S., Hashimoto, T.; Hayashita, T.

Phosphate derivatives recognition by supramolecular complex sensor based on phenylboronic acid-modified cyclodextrin

3-Fluorophenyl boronic acid, BCD, Dipicolylamine

P67 Cecone, C.; Caldera, F.; Aneschi, A.; Scalarone, D.; Trotta, F.; Bracco, P.; Zanetti, M.

One-step facile process to obtain insoluble polysaccharides fibrous mats from electrospinning of water-soluble cyclodextrin polymers

Hyper-branched water-soluble polymer, Thermal treatment

P68 Villaneuva, D.; Zornoza, A.; Vélaz, I.

Ketoprofen release studies from insoluble β-cyclodextrin polymers

Epichlorohydrin, Retarded release

P69 Lucio, D.; Irache, J.M.; Zornoza, A.; Mírtinez-Oháriz, M.C,

Aggregation of glibenclamide-cyclodextrin complexes

HPBCD, RAMEB, Coexistence of inclusion and non-inclusion phenomena, Nanoaggregates

P70 Argenziano, M.; Ferrara, B.; Caldera, F.; Lombardi, C.; Trotta, F.; Prandi, C., Dianzani, C.; Cavalli, R.

Enhanced intracellular delivery of strigolactone analogue by pH-responsive

β-cyclodextrin-nanosponge in cancer cells

Pyromellitic anhydride, Crosslinking agent, Cytotoxicity

P71 Kazama, A.; Shigemitsu, H.; Kida, T.

Synthesis and inclusion ability of novel α-cyclodextrin dimers

Heptakis(6-O-tert-butyldimethylsilyl) BCD, m-Xylylene dibromide, Janus type ACD dimer

P72 Iguchi, H.; Ito, S.; Shigemitsu, H.; Kida, T.

Inclusion ability of β- and γ-cyclodextrin dimers bearing multiple linkers

Heptakis(6-O-tert-butyldimethylsilyl) BCD, GCD dimer, Janus type, Xylylene linkers, Desilylation

P73 Fujiwara, S.; Yamada, T., Fujita, K.; Hashimoto, T.; Hayashita, T.

Development of dipicolylamine probe modified cyclodextrin for ATP sensing in water

Pyrophosphate, Adenosine triphosphate, Cu-complex, Discrimination of a purine base from a pyrimidine base

P74 Zagami, R.; Pipkin, J.D.; Antle, V.; Monsu Scolarlo, L.; Mazzaglia, A.

Novel nanogel based on CAPTISOL ® and a cationic porphyrin with the potential for PAT

Photodynamic antimicrobial therapy (PAT), Phase solubility study, meso-Tetrakis(N-methylpyridinium-4-yl)porphine, Photosensitizer, Nanoassemblies

P75 Zagami, R.; Sortino, G.; Caruso, E.; Malacarne, M.C.; Banfi, S.; Monsu Scolarno, L., Mazzaglia, A.

Supramolecular assemblies based on bodipy/amphiphilic cyclodextrin as nanophototherapeutics with PDT efficacy

Photostability, Photosenzitisation, Heptakis(2-O-oligo(ethylene oxide)-6-hexylthio)-BCD, Aggregation, Intracellular localization

P76 Larsen, K.L.; Tjell, A.O.; Aaachmann, F.L.

Compatibility of cyclodextrins and Ca^{++}-alginate hydrogels

BCD, HPBCD, SBE-BCD, Mechanical behavior, Chelating ability

P77 Liu, C.; Mayumi, K.; Kato, K.; Yokoyama, H.; Ito, K.

Fracture of slide-ring gels with movable cross-links

Softness, Stretchability, Strain, Young's modulus, Fracture energy, Polyethylene glycol

P78 Yasuda, Y.; Mayumi, K.; Toda, M.; Yokoyama, H.; Morita, H.; Ito, K.

Coarse-grained MD simulations of polyrotaxanes and slide-ring gels

Diffusion coefficient, Fixed chains, Fluctuating chains, Elastic modulus, Strain hardening

P79 Uenuma, S.; Maeda, R.; Mayumi, K.; Kato, K.; Yokoyama, H.; Ito, K.

Self-assembly and mechanical properties of polyrotaxane consisting of cyclodextins and triblock copolymer

Tail-type, Bridge type, Loop-type configuration, Monomer sequence, PEO, PPO, PEO triblock copolymer, Microphase, Trimethylsilyl groups

P80 Morita, K., Higashi, T.; Song, X.; Zhu, J.; Li, J.; Tamura, A.; Yui, N.; Motoyama, K.; Arinma, H.

One-pot synthesis and facile isolation of cyclodextrin-based polycatenanes

PEG-PPG-PEG, Dithiothreitol, Pluronic, Cyclization, Disulfide bond

P81 Maeda, R.; Kobayashi, R.; Uenuma, S., Mayumi, K.; Yokoyama, H., Ito, K.

Polyrotaxane made of a self-assembling cyclodextrins with weak hydrophobic interactions shows viscoelastic, self-recovering and self-adhering property

CD functionalized by trimethylsilyl and trimethylsilyloxy groups, Rubber elasticity, Stress-strain curve

P82 Takemoto, Y.; Okada, S.; Tsuchido, Y.,Fujiwara, S.; Hashimoto, T.; Hayashita, T.

Inclusion behavior and metal recognition by dipycolylamine type nitrophenylazoprobe/cyclodextrin complexes

p-Nitroazaphenol, 1.2-dibromoethane, Cotton effect, GCD

P83 Komatsuzaki, M.; Fukushima, M.; Fujiwara, S.; Hashimoto, T.; Hayashita, T.

Design and function of fluorescent probe/cyclodextrin complexes for saccharides recognition in water

Phenylboronic acid, Naphthalene, Galactose

P84 Hayashi, T.; Motoyama, K.; Higashi, T.; Iishi, K.; Arima, H.

Cooperative immunostimulation by combined adjuvants of 2-hydroxypropyl-β-cyclodextrin and CpG-ODN

Synergistic adjuvant effect, HPBCD, Oval albumin, Antigen, IgG1, IgG2c

P85 Fu, H.G.; Chen, Y.; Liu, Y.

A ruthenium-based cyclodextrin assembly for singlet oxygen generation in water

DNA carrier, Luminescence

P86 Zhang, H.Y.; Cheng, J.G.; Liu, Y.

Photo-controlled reversible conversion of nanowire and nanoparticle based on negatively charged cyclodextrin

External stimuli, Amphiphilic azobenzene derivative, Nanoparticle, Nanowire

P87 Chen, Y.; Cheng, J.G.; Liu, Y.

Selective binding of anticancer drugs by polyanionic cyclodextrins

Irinotecan, Topotecan, Doxorubicin

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