

## Worldwide Patent Protection



Production of nanocapsules and microcapsules by layer-wise polyelectrolyte self-assembly

Donath, Sukhorukov, Lerche, Voigt, Bäumlér, Caruso, Möhwald; WO 99/47252; international filing date: 19.03.1999; priority date: 19.03.1998, 15.07.1998, 22.02.1999; registered design (DE 299 24 358 U1)

Claimed are polyelectrolyte layer-by-layer capsules per se and containing active substances at colloid size level (up to about 10 $\mu$ m). Claimed is also the method for their efficient preparation. Examples comprise inter alia dissolvable melamine formaldehyde templates for hollow capsule preparation.

Fabrication of Multilayer-Coated Particles and Hollow Shells via Electrostatic Self-Assembly of Nanocomposite Multilayers on Decomposable Colloidal Templates

Caruso, Caruso, Donath, Möhwald, Sukhorukov; WO 99/47253; international filing date: 19.03.1999; priority date: 19.03.1998, 15.07.1998; USA patent granted (US 6 479 146); EP patent granted (EP 1 064 088)

Claimed are layer-by-layer capsules consisting of polyelectrolytes and charged nanoparticles as layer components. They form hybrid organic/inorganic multilayered closed structures at colloid size level templates. Claimed are also capsules derived therefrom as hybrid hollow shells.

Polyelectrolyte coverings on biological templates

Neu, Bäumlér, Donath, Moya, Sukhorukov, Möhwald, Caruso; WO 00/03797; international filing date: 15.07.1999; priority date: 15.07.1998, 22.02.1999; USA patent granted (US 6 699 509)

Claimed are special types of capsules consisting of shells templated at cores of biogenic origin, e.g., biological cells, liposomes, cell organelles, pollen grains etc. The hollow shells are covalently cross-linked during core dissolution by oxydation. Claimed are also multilayered capsules and shells additionally covered by lipid bilayers forming supported liposome or vesicle structures.

Encapsulation of crystals via multilayer coatings

Caruso, Trau, Möhwald, Renneberg; WO 00/77281; international filing date: 09.06.2000; priority date: 10.06.1999; USA patent granted (US 6 833 192); EP patent granted (EP 1 190 123); registered design (DE 200 23 081 U1)

Claimed are layer-by-layer capsules at crystalline templates and cores of colloid size which comprise inorganic and/or organic substances. Potential cores/templates are enzymes, nucleic acids, proteins, active substances, hybrid structures etc.



#### Templating of solid particles by polymer multilayers

Caruso, Trau, Möhwald, Renneberg; WO 01/51196; international filing date: 12.01.2001; priority date: 13.01.2000, 29.05.2000; EP patent granted (EP 0 190 03 643.3)

Claimed are layer-by-layer capsules at uncharged or low-charged templates of colloid size cores. Before consecutive coating the templates are equipped by an amphiphilic and/or charge carrying precursor layer. Poorly soluble drugs can serve as template substances. Claimed are also the applications of these multilayered capsules as part of sensors and for analytical and information technological purposes.

#### Production of polyelectrolyte capsules by surface precipitation

Voigt, Sukhorukov, Radtchenkov, Antipov, Donath, Möhwald; WO 02/09865; international filing date: 01.08.2001; priority date: 02.08.2000, 11.10.2000; EP patent granted (EP 1 305 109)

Claimed are polyelectrolyte multilayer structures similar to layer-by-layer ones precipitated by one-step reaction onto templates of colloid size. Core dissolution can result in hollow shell-like structures.

#### Controlled and sustained release properties of polyelectrolyte multilayer capsules

Antipov, Vieira, Ibarz, Sukhorukov, Dähne, Gao, Donath, Möhwald; WO 02/17888; international filing date: 28.08.2001; priority date: 28.08.2000, 23.05.2001; EP patent granted (number to be submitted)

Claimed is control and means of control of permeability of polyelectrolyte layer-by-layer capsules of colloid size. Control parameters are of physicochemical nature, like pH, ionic strength, salt and solvent composition. They can act during and after capsule preparation and during the application period. Claimed is also the influence of shell component properties (e.g., molecular weight, polarity, charge density, hydrophobicity) on permeability control.

#### Pharmacological composition containing polyelectrolyte complexes in microparticulate form and at least one active agent

Krone, Magerstadt, Walch, Groner, Hoffmann; international filing date: 23.04.91; EP 0454044/JP 3168215/US 5700459/CA 2041093

Claimed is the formation of polyelectrolyte complex nano- and microparticles containing an active substance (drug) by co-precipitation. The particles are biocompatible and offer a wide range of release kinetics. Claimed is also the polyelectrolyte complex/active substance containing composition ensuring that the active agent is converted into a form which can be administered, thus beneficially affecting the biodistribution, bioavailability and absorption of the pharmaceutically active substance.



Color coated layer-by-layer microcapsules serving as combinatorial analysis libraries and as specific optical sensors  
Dähne, Baude, Voigt; WO 2004/014540 A1; international filing date: 29.07.2003; priority date: 02. 08.2002, 02.04.2003

Claimed are libraries of multiple fluorescence dye labelled layer-by-layer capsules. FRET is used as sensor principle between intra- and interlayer fluorescence dye interactions in layer-by-layer capsules.

Fast releasing delivery system for poorly soluble active substance

Mayer, Cremer, Kröhne; PCT/EP03/10630; international filing date; 24.09.2003; priority date: 25.09.2002

Claimed is the fast release of poorly soluble active substance by stabilizing the highly dispersed state of it with polyelectrolyte multilayers obtained by layer-by-layer coating.

Method and device for modification of microparticles

Voigt, Dähne; PCT/EP03/12904; international filing date: 18.11.2003; priority date: 22.11.2002

Claimed is the layer-by-layer coating of micro- and nanoparticles trapped in gel medium. The transport of the charged polyelectrolytes/nanoparticles to and away from the particles is realized by electric and/or other field induced forces.



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