Short Curriculum Vitae and summary of scientific activities

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Born : May 20, 1956   Nationality : German

Academic Degrees

- 1994 : Privatdozent for Physical Chemistry (Habilitation), J. Gutenberg-Universität, Mainz, Germany
- 1986 : Dr. rer. nat. in Organic Chemistry Johannes Gutenberg-Universität, Mainz, Germany
- 1983 : Diploma in Chemistry, Philipps Universität, Marburg, Germany

Career and Appointments

- since 2006 : Professeur classe exceptionnelle (distinguished professor), Université Louis Pasteur, Strasbourg, France
- since 2001 : Associate director of the Institut Charles Sadron (CNRS, UPR 22)
- since 1995 : Professeur de Chimie (full professor, PR1), Université Louis Pasteur, Strasbourg, France
- 1994-1995 : Professeur associé (visiting professor), Université Louis Pasteur, Strasbourg, France
- 1988-1994 : Hochschulassistent, Johannes Gutenberg-Universität, Mainz, Germany
- 1986-1988 : Postdoctoral fellow, CIBA-GEIGY AG (Department of Polymers and Additives), Fribourg, Switzerland

Fields of Competence

Development of the layer-by-layer assembly method, macromolecules at interfaces, composite biomaterials, (bio)-functional nanoparticles, functional coatings, thin film devices

Executive summary of scientific production and impact

total number of publications	112	
refereed publications	94	
proceedings	6	
book chapters	6	
outreach articles and others	6	
books	1	
patents	9	+ 1 in preparation
total number of ISI-citations	10431	(as of February 2008)
average number of citations per article	93	
average number of citations per month (2005-2007)	110	
h index	42	calculated according to : J. E. Hirsch
m index	1,9	Proc. Nat. Acad. Sci. USA 102 (2005), 16569
total number of oral presentations	192	
total number of invited presentations	161	
total number of special invited presentations (plenary and keynote)	14	(11 international and 3 national)
number of regular invited conferences	84	(74 international and 10 national)
number of contributed conferences	32	(21 international and 11 national)
number of invited seminars	62	

2008 : Most cited article in the field of chemistry of the last 10 years in the journals *SCIENCE* and *NATURE* combined
2008 : Second most cited single author article of all fields of the last 10 years in the journals *SCIENCE* and *NATURE* combined

Distinctions

* 2007 nomination as senior member of the IUF (Institut Universitaire de France, promotion of 2006)
* 1999 Annual award of the Groupe Français des Polymères (GFP), (polymer division of the Société Française de Chimie)
* 1991 Richard-Zsigmondy award of the "German Colloid Society"

PROFESSIONAL ACTIVITIES

since 2005	Co-Editor of the American Institute of Physics journal “Biointerphases”
since 2005	In charge of the thematic action “Nano-objets et Matériaux Nanostructurés, Moléculaires, Macromoléculaires et Supramoléculaires” of the Centre Nano Grand Est.
2005-2007	Membre nommé de Conseil de l’Ecole Doctorale Jean Henri LAMBERT à Mulhouse (UHA ED 271)
2004 - 2007	**Membre nommé du Comité National (CNRS, Section 11)**
2001 - 2004	Member of the editorial board of the American Chemical Society journal "Nano Letters"
since 2001	**Associate Director of the Institut Charles Sadron (CNRS, UPR 22)**
2000 - 2005	**Director of the DEA program "Chimie et Physique des Polymères, Matériaux et Surfaces"**
since 1998	Member of the "commission de spécialistes 32ème section" of the Université Louis Pasteur
since 1997	Member of the "Conseil de Laboratoire" of the Institut Charles Sadron
1997 - 2005	Member of the "Conseil de l'Ecole Doctorale de Physique et Chimie-Physique de Strasbourg"
1997 - 2002	Head of the departement "Chimie des Systèmes Associatifs" of the Institut Charles Sadron
1995 - 2004	Director of the graduate program "Chimie et Physicochimie Macromoléculaire"
1994 - 1998	Member of the editorial board of the Elsevier journal "Supramolecular Science"
	Referee for over 20 scientific journals (including Science, JACS, Adv. Mater., Langmuir, Angew. Chem., Macromolecules, …)
	Referee for scientific programs and projects for the MRT (France), DFG (Germany), BMBF (Germany), Fraunhofer Gesellschaft (Germany) and SON (Netherlands).
	Member or president of the jury or referee for more than 40 PhD thesis (since 1996)

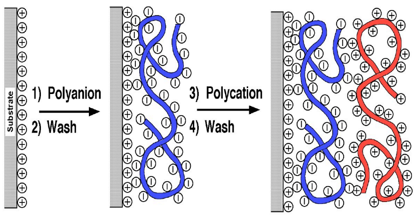
Concise introduction to our research activities

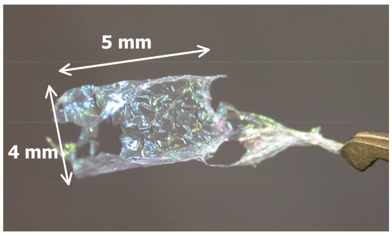
The surface of a given object controls its interaction with its environment, thus the modification and functionalization of surfaces has enormous impact in very different fields of research: biocompatibilisation of implants, biosensors, anticorrosive coatings, antireflective coatings, antistatic coatings, cosmetics or medical diagnostics and therapy to name a few.

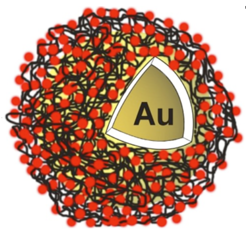
Our team has been working on several aspects of chemically tailoring surfaces for different purposes. With our early work we had a respectable breakthrough using LB-films for nonlinear optics and very recently with the formation of nanotubes by self-assembly. However, our biggest success and our most important present activity is our invention and development of the so-called layer-by-layer (LBL) assembly method. In contrast to previous theoretical predictions, the adsorption of polyelectrolytes onto oppositely charged surfaces does lead to a charge overcompensation, which is the molecular base for our method.

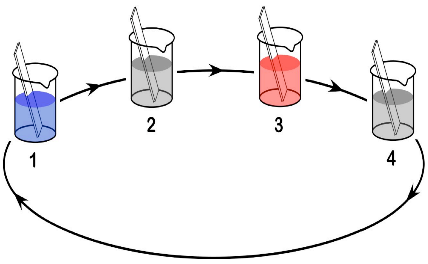
This new self-assembly method is a true bottom-up approach that leads to nano-organized multimaterial films. It is based on a straightforward concept (attractive intermolecular interaction, mostly electrostatic in nature) and combines experimental ease with low cost fabrication and environmental friendliness. Due to the broad range of materials that can be put into multilayers on substrates of almost every shape and every size, it has developed during the last 15 years from a scientific curiosity in fundamental research to an enabling technology which is in the process of being transformed into a tool for commercial mass production.

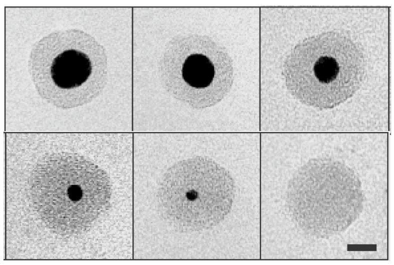
The following 6 images show schematics of LBL-deposition (upper left) the dipping process (lower left), a freely-suspended film composed of 160 individual layers with a total thickness of 200 nm (upper middle), a functionalized nanoparticle (upper right), coated nanoparticles (lower middle) and a commercial product that was introduced to the Japanese market in 2000 (lower right). Today LBL-technology has been used for the fabrication of 4 different products.











It is a pleasure to mention that in an evaluation of the National Academy of Sciences (NAS) and the National Research Council (NRC) of the United States of America in 2006, our team was considered to be among the 8 worldwide leading teams in the field of self-assembly.

Major Scientific Achievements in Chronological Order

(Citation numbers as of Feb. 2008)

1988/89 Fabrication of the first non-centrosymmetric optical waveguide for second harmonic generation using Langmuir-Blodgett multilayers. (1989 as postdoc with CIBA-GEIGY, in collaboration with P. Günter at the Physics Dept. at the ETH for the non-linear optical measurements) The new in-plane polar structure of these films proved rather interesting and later led to funding of further studies. Non-centrosymmetry in this stable Y-type structure requires only a single amphiphile as it is controlled by the deposition conditions. Thus our finding reduces structural complexity in the films and allows deposition from conventional LB-troughs. (publ. # 10, J. Chem. Soc., Chem. Commun. 933-934 (1988), 79 citations and publ. # 11, Ferroelectrics 91, 193-207 (1989), 62 citations).

1995 First preparation of freely-suspended liquid crystal films from polymeric materials (with polymers from R. Zentel and H. Ringsdorf in Mainz), which was considered impossible after several unsuccessful attempts by other groups. An interesting side-aspect was further stabilization of such films by transfer on solid substrates (with J. Maclennan). Films of this type show very high degrees of orientation and order and only a small number of defects, in certain cases one could speak of optical monodomains. Thus such films are interesting with respect to structural studies and also for applications. (publ. # 18, Appl. Phys. Lett. 59, 917-919 (1991), 23 citations, publ. # 25, Thin Solid Films 210/211, 504-507 (1992), 23 citations, publ. # 47, Advanced Materials 7(10), 849-852 (1995) 11 citations and publ. # 27, Langmuir 9, 341-346 (1993), 43 citations)

Since 1990 Fabrication and characterization of **molecular multilayer films** by consecutive adsorption or chemisorption from solution. For the work on layer-by-layer adsorption of polyanions and polycations, I have received the R. Zsigmondy award of the German Colloid Society in 1991. This area has, in the meantime, become the focus of my research interests.

After our first publication in 1991, there are today over 200 independent groups worldwide working in the area of polyelectrolyte multilayers. In addition to our more than 60 publications in this domain, the other groups have contributed over 3000 publications since 1993. Due to its general applicability to organic, polymeric inorganic and biological materials and due to its simplicity our nanofabrication process has prompted applied research in domains such as tissue engineering, functionalisation of implants, gene delivery and transfection, biosensing, biocatalysis, electroluminescent devices, lithium-ion-batteries, non-linear optics, anti-reflective coatings, corrosion protection, photocatalysis, microreactors, gas and liquid separation, functionalisation of nanoparticles, controlled drug release and some others.

1991 Proof of concept that the consecutive electrostatic adsoption works, the example being bolaform amphiphiles with identical charges at both ends. (publ. # 17, Makromol. Chem., Macromol. Symp. **46**, 321-327 (1991), 560 citations)

1991 Proof that bolaform amphiphiles can be alternated with simple polyelectrolytes that are not shape persistent. (publ. # 20, Ber. Bunsenges. Phys. Chem. **95** (11), 1430-1434 (1991), 492 citations)

1992 Proof that simple oppositely charged polyelectrolytes can be consecutively deposited in multilayer films. (publ. # 23, Thin Solid Films **210/211**, 831-835 (1992), 948 citations)

1992 Demonstration how the layer thickness of polyelectrolyte films can be controlled with Ångstrom precision by adjusting the ionic strength of the deposition solution. In contrast to solutions of polyelectrolytes where the radius of gyration ***decreases*** with increasing ionic strength, the layer thickness ***increases*** with ionic strength. (publ. # 26, Progr. Colloid Polym. Sci. **89**, 160-164 (1992), 217 citations).

1993 Proof that complex biomacromolecules like DNA can be used for LBL deposition (publ. # 29, Macromolecules **26** (20), 5396-5399 (1993), 230 citations and publ. # 50, extension to other polynucleotides in Thin Solid Films **284/285**, 220-223 (1996), 84 citations).

1993 Proof for a superlattice structure in LBL-fims by neutron reflectometry using deuterated poly(styrene sulfonate). (publ. # 37, Macromolecules **26**, 7058-7063 (1993), 207 citations). Refinement of the structure in 1998 (publ. # 60, Macromolecules **31** (25), 8893-8906 (1998), 243 citations).

1994 First incorporation of a biological nanoparticle (a charged virus) in multilayer films. (publ. # 41, Langmuir **10** (11), 4232-4236 (1994), 135 citations).

1997 The plasmon shift of gold nanoparticles and their high electron density reveal detailed structural information on polyelectrolyte/nanoparticle films of different architecture by optical measurements in combination with x-ray reflectivity. (publ. # 56, Advanced Materials **9** (1), 61-65 (1997), 298 citations).

1997 Detailed discussion of the fuzzy layer structure in polyelectrolyte multilayers resolving the problem of a somewhat stratified structure of the films and a polyanion polycation stoichiometry of 1:1. Detailed review on the state of the art and on perspectives for future applications. **Feature article for special issue on "Frontiers in Materials Science"**. (publ. # 54, Science **277** (5330), 1232-1237 (1997), 2659 citations).

Most cited manuscript of all articles published in Nature or Science in the field of chemistry in the last 10 years (1997-2008).

1998 First use of the concept that multilayer films can simply be functionalized by grafting functional molecules to polyelectrolytes, an approach superior to the direct grafting of functional molecules onto surfaces. In contrast to direct grafting our approach allows to analyze the functionalized polymers in detail in solution and to deposit them onto different substrates using the mild and standardized conditions of LBL-assembly. The first example uses biotinylated poly(l-lysine). (publ. # 57, Supramolecular Science **5** (3-4), 309-315 (1998), 36 citations).

2000 Integration of titania nanosheets into multilayer films e.g. for use as self-cleaning surfaces. (publ. # 71 Chem. Commun. (21), 2163-2164 (2000), 51 citations and publ. # 76 Chem. of Materials **13** (12), 4661-4667 (2001), 85 citations).

2000 Integration of LBL-deposition with Langmuir-Blodgett films. (publ. # 70, Langmuir **16** (23), 8871-8878 (2000), 128 citations).

2001 Further extension of the previous concept to peptide hormones which maintain their biological activity when incorporated into a multilayer film. (publ. # 72, Biomacromolecules **2** (3), 800-805 (2001), 112 citations).

2001 Demonstration how precisely the architecture of organic light emitting diodes can be adjusted and their performance can dramatically be improved, by putting electrically insulating layers at different positions. (publ. # 73, Nano Letters **1** (1), 45-49 (2001), 56 citations)

2003 Demonstration how the film architecture controls its interaction with cells. (publ. # 83, Advanced Materials **15** (9), 692-695 (2003), 82 citations).

2004 Direct evidence for vertical diffusion and exchange processes of polyanions and polycations in polyelectrolyte multilayer films. (publ. # 87, Macromolecules **37** (3), 1159-1162 (2004), 29 citations).

2005 Demonstration that LBL-deposition can be enormously accelerated by changing the deposition from dipping to spraying. Despite a reduction of the deposition time by a factor of up to 150, the film quality remains good or is slightly improved. These results lead to many new and fundamental questions why spraying is so different than dipping. One of these questions is why the layer thickness is about 25% thinner with spraying in comparison to dipping (publ. # 93, Langmuir **21** (16), 7558-7567 (2005), 14 citations)

2006 Investigations on releasing LBL-films from the substrate at physiological conditions. (publ. # 102, Nano Letters **6** (4), 592-598 (2006), 10 citations).

2006 First fabrication of “cytotoxic stealth nanoparticles” for enhanced targeting of human cancer. (Manuscript currently submitted.)

2006 Proof that the concept of film functionalization by using functionalized polyelectrolytes can be applied to nanoparticles. This leads to the interesting effect of distant depending quenching of polymer-attached fluorescent chromophores by the metal particle core. (publ. # 101, Nano Letters **6** (3), 530-536 (2006), 20 citations, and earlier work, publ. # 91, Nano Letters **4** (10), 1833-1839, 46 citations).

2007 Optimisation of the parameters controlling LBL-deposition on nanoparticles and beginning of the scale-up of the process. The fact that there is an optimum molar excess of polyelectrolytes over the nanoparticle concentration is quite surprising. (publ. # 111, Langmuir ASAP)

2007 Development of mechanically robust LBL-films. (Manuscript in preparation)

2007 Determination of the structural parameters of LBL-films as a function of the deposition method. Neutron reflectometry. (Manuscript in preparation)

2007 LBL-films for use in an artificial pancreas. (Manuscript in preparation)

2007 LBL-films for tissue engineering. (Manuscript in preparation)