REFERENCES

[1] Lau, K. T., Cheung, H. Y., Lu, J., Yin, Y. S., Hui, D. and Li, H. L. Carbon nanotubes for space and bio-engineering applications. Journal of Computational and Theoretical Nanoscience 5 (2008): 23-35.

[2] Prato, M., Kostarelos, K. and Bianco, A. Functionalized carbon nanotubes in drug design and discovery. Accounts of Chemical Research 41 (2008): 60-68.

[3] Rivas, G. A., Rubianes, M. D., Rodriguez, M. C., Ferreyra, N. E., Luque, G. L., Pedano, M. L., Miscoria, S. A. and Parrado, C. Carbon nanotubes for electrochemical biosensing. Talanta 74 (2007): 291-307.

[4] Yaghoobi, P. and Nojeh, A., Electron emission from carbon nanotubes. Modern Physics Letters B 21 (2007): 1807-1830.

[5] Yogeswaran, U. and Chen, S. M. Recent trends in the application of carbon nanotubes-polymer composite modified electrodes for biosensors: A review. Analytical Letters 41 (2008): 210-243.

[6] Cao, G. Nanostructures and nanomaterials: synthesis, properties and applications. Eds, Imperial college press, 2004.

[7] Pestryakov, A. N., Bogdanchikova, N., Simakov, A., Tuzovskaya, I., Jentoft, F., Farias, M. and Diaz, A. Catalytically active gold clusters and nanoparticles for CO oxidation. Surface Science 601 (2007): 3792-3795.

[8] Bell, N. S., Tallan, D. R., Raymond, R. and Boyle, T. J. Synthesis and self-assembly of zinc oxide nanoparticles with septahedral morphology. Journal of Materials Research 23 (2008): 529-535.

[9] Hu, Y., Jiang, X. Q., Ding, Y., Ge, H. X., Yuan, Y. Y. and Yang, C. Z. Synthesis and characterization of chitosan-poly(acrylic acid) nanoparticles. Biomaterials 23 (2002): 3193-3201.

[10] Kobayashi, M., Petrykin, V. V. and Kakihana, M., One-step synthesis of TiO_2 nanoparticles from a 'Water-Soluble titanium complex. Chemistry of Materials 19 (2007): 5373-5376.

[11] Liu, H. G., Xiao, F., Wang, C. W., Lee, Y. I., Xue, Q., Chen, X., Qian, D. J. Hao, J. and Jiang, J. One-step synthesis of silver nanoparticles at the air-water interface using different methods. Nanotechnology 19 (2008): 222-225.

[12] Lu, J. and Ng, K. M., Efficient, one-step mechanochemical process for the synthesis of ZnO nanoparticles. Industrial & Engineering Chemistry Research 47 (2008): 1095-1101.

[13] Lu, X. M., Tnan, H. Y., Korgel, B. A. and Xia, Y. N., Facile synthesis of gold nanoparticles with narrow size distribution by using AuCl or AuBr as the precursor. Chemistry-a European Journal 14 (2008): 1584-1591.

[14] Mi, F. L., Wu, Y. Y., Chiu, Y. L., Chen, M. C., Sung, H. W., Yu, S. H., Shyu, S. S. and Huang, M. F., Synthesis of a novel glycoconjugated chitosan and preparation of its derived nanoparticles for targeting HepG2 cells. Biomacromolecules 8 (2007): 892-898.

[15] Park, Y. S., Dmytruk, A., Drnitruk, I., Yasuto, N., Kasuya, A., Takeda, M. and Ohuchi, N., Aqueous-phase synthesis of ultra-stable small CdSe nanoparticles. Journal of Nanoscience and Nanotechnology 7 (2007): 3750-3753.

[16] Singh, P., Katyal, A., Kalra, R. and Chandra, R., Copper nanoparticles in an ionic liquid: an efficient catalyst for the synthesis of bis-(4-hydroxy-2-oxothiazolyl)methanes. Tetrahedron Letters 49 (2008): 727-730.

[17] Son, J. H., Park, H. Y., Kang, D. P. and Bae, D. S., Synthesis and characterization of Ag/Pd doped SiO2 nanoparticles by a reverse micelle and sol-gel processing. Colloids and Surfaces a-Physicochemical and Engineering Aspects 313 (2008) 105-107.

[18] Subramania, A., Kumar, G. V., Priya, A. R. S. and Vasudevan, T., Polyol-mediated thermolysis process for the synthesis of MgO nanoparticles and nanowires. Nanotechnology 18 (2007): 267-270.

[19] Sun, Z. X., Zhang, Q., Lu, Y. H. and Li, Y. L., Synthesis of mesoporous ZnS nanoparticles with enlargeable pore size through a co-template approach. Microporous and Mesoporous Materials 109 (2008): 376-382.

[20] Wang, L., Qi, B., Sun, L. L., Sun, Y. J., Guo, C. L. and Li, Z. A., Synthesis and assembly of Au-Pt bimetallic nanoparticles. Materials Letters 62 (2008): 1279-1282.

[21] Osinski, M., Special section on colloidal quantum dots for biomedical applications. Ieee Transactions on Nanobioscience 5 (2006): 221-221.

[22] Reddy, K. M., Feris, K., Bell, J., Wingett, D. G., Hanley, C. and Punnoose, A., Selective toxicity of zinc oxide nanoparticles to prokaryotic and eukaryotic systems. Applied Physics Letters 90 (2007).

[23] Xie, F. L., Lampi, M. A., Dixon, D. G. and Greenberg, B. M., Assessment of the toxicity of mixtures of nickel or cadmium with 9,10-phenanthrenequinone to Daphnia magna: Impact of a reactive oxygen-mediated mechanism with different redox-active metals. Environmental Toxicology and Chemistry 26 (2007): 1425-1432.

[24] Daniel, M. C. and Astruc, D. Gold nanoparticles: Assembly, supramolecular chemistry, quantum-size-related properties, and applications toward biology, catalysis, and nanotechnology. Chemical Reviews 104 (2004): 293-346.

[25] Kelly K.L., Coronado E., and Zhao L.L. The optical properties of metal nanoparticles: The influence of size, shape, and dielectric environment. J Phys Chem B 107 (2003): 668-677.

[26] Perez-Juste J., Pastoriza-Santos I., Liz-Marzan L.M., and Mulvaney P. Gold nanorods: Synthesis, characterization and applications. Coordin Chem Rev 249 (2005): 1870-1901.

[27] Daniel M.C., and Astruc D. Gold nanoparticles: Assembly, supramolecular chemistry, quantum-size-related properties, and applications toward biology, catalysis, and nanotechnology. Gold Chem Rev 104 (2004): 293-346.

[28] Velasco-Garcia, M.N., Mottram, T. Biosensor Technology addressing Agricultural Problems. Biosystems Engineering 84 (2003): 1-12.

[29] Ngundi, M.M., Kulagina, N.V., Anderson, G.P., Taitt, C.R. Expert Rev Proteomics 3 (2006): 511-524.

[30] Lapenaite, I., Ramanaviciene, A., Ramanavicius, A. Current Trends in Enzymatic Determination of Glycerol Cri. Rev Anal Chem 36 (2006): 13-25.

[31] Odenthal, K. J. and Gooding, J. J. An introduction to electrochemical DNA biosensors. Analyst 132 (2007): 603-610.

[32] Crespilho, F. N. and Rezende, M. O. O. Carbon paste electrodes modified with humic acids: Study and determination of metals in aqueous solution. Quim Nova 27 (2004): 964-969.

[33] Airoldi, F. P. S., Da Silva, W. T. L., Crespilho, F. N. and Rezende M. O. O. Carbon Paste Electrode Modified by humic Acids. Water Environ Res 79 (2007): 63-67.

[34] Crespilho, F. N., Zucolotto, V., Siqueira, J. R., Constantino, C. J. L., Nart, F. C. and Oliveira, O. N. Immobilization of humic acid in nanostructured layer-by-layer films for sensing applications. Jr. Environ Sci Technol 39 (2005): 5385-5389.

[35] Masson, J., Battagliaa, T. M., Kima, Y., Prakasha, A., Beaudoinb, S. and Booksh, K. S. Preparation of analyte-sensitive polymeric supports for biochemical sensors. Talanta 64 (2004): 716-725.

[36] Frederix, F., Friedt, J., Choi, K., Laureyn, W., Campitelli, A., Mondelaers, D., Maes, G. and Borghs, G. Biosensing Based on Light Absorption of Nanoscaled Gold and Silver Particles. Anal Chem 75 (2003): 6894-6900.

[37] Kelly, K. L., Coronado, E., Zhao, L. L. and Schatz, G. C. J Phys Chem B 107 (2003): 668-677.

[38] Frederix, B. F., Friedt, J., Choi, K., Laureyn, W., Campitelli, A., Mondelaers, D., Maes, G. and Borghs, G. The Optical Properties of Metal Nanoparticles: The Influence of Size, Shape, and Dielectric Environment. Anal Chem 75 (2003): 6894-6900.

[39] Warneck, P., Chemistry of the Natural Atmosphere. Academic Press Inc., 1998.

[40] Pijolat, C., Pupier, C., Sauvan, M., Tournier G., and Lalauze, R. Gas detection for automotive pollution control. Sens. Actuators, B 59 (1999): 195-199.

[41] Durbin, T. D., Wilson, R. D., Norbeck, J. M., Miller, J. W., Huai T. and Rhee, S. H. Estimates of the emission rates of ammonia from light-duty vehicles using standard chassis dynamometer test cycles. Atmos. Environ., 36 (2002): 1475-1480.

[42] Ament, W., Huizenga, J. R., Kort, E., Van Der Mark, T. W., Grevink R. G. and Verkerke, G. J. Respiratory ammonia output and blood ammonia concentration during incremental exercise. International Journal of Sports Medicine, 20 (1999): 71-73.

[43] Narasimhan, L. R., Goodman W. and Patel, N. Correlation of breath ammonia with blood urea nitrogen and creatinine during hemodialysis. Proc. Natl. Acad. Sci. U. S. A., 98 (2001): 46174620.

[44] Zakrzewska, K. Mixed oxides as gas sensors. Thin Solid Films, 391 (2001) 229.

[45] Sahm, M., Oprea, A., Barsan N. and Weimar, U. Water and ammonia influence on the conduction mechanisms in polyacrylic acid films. Sens. Actuators, B, 127 (2007): 204-210.

[46] Wang, X., Miura N. and Yamazoe, N. Study of WO3-based sensing materials for NH3 and NO detection. Sens. Actuators, B, 66 (2000) 74.

[47] Shen Y. and Prasad P. N. Nanophotonics: a new multidisciplinary frontier. Appl Phys B-Lasers O 74 (2002): 641-645.

[48] Guo H. and Tao S. Silver nanoparticles doped silica nanocomposites coated on an optical fiber for ammonia sensing. Sensor Actuat B-Chem 123 (2007): 578-582.

[49] Kelly K. L., Coronado E., Zhao L. L. and Schatz G. C. The optical properties of metal nanoparticles: The influence of size, shape, and dielectric environment. J Phys Chem B 107 (2003): 668-677.

[50] Perez-juste J., Pastoriza-Santos I., Liz-Marzan L. and Mulvaney P. Gold nanorods: Synthesis, characterization and applications. Coordin chem rev 249 (2005): 1870-1901.

[51] Kreibig U., Vollmer M. and Toennies J. P. optical properties of metal clusters, Springer-verlag: Berlin 1995.

[52] Link S. and El-Sayed M. A. Shape and size dependence of radiative, non-radiative and photothermal properties of gold nanocrystals. Int Rev Phys Chem 19 (2000): 409-453.

[53] Storhoff J. J., Elghanian R., Mucic R. C., Mirkin C. A. and Letsinger R. L. One-pot colorimetric differentiation of polynucleotides with single base imperfections using gold nanoparticle probes. J Am Chem Soc 120 (1998): 1959-1964.

[54] Rex M, Hernandez FE, Campiglia AD. Pushing the limits of mercury sensors with gold nanorods. Analytical Chemistry 78 (2006): 445-451.

[55] Huang, M. H., Shao, Y., Sun, X. P., Chen, H. J., Liu, B. F. and Dong, S. J. Alternate assemblies of platinum nanoparticles and Metalloporphyrins as tunable electrocatalysts for dioxygen reduction. Langmuir 21 (2005): 323-329.

[56] Di Natale C., Salimbeni D., and Paolesse R. Porphyrins-based opto-electronic nose for volatile compounds detection. Sensor Actuat B-Chem 65 (2000): 220-226.

[57] Li, Z., Lee, D., Sheng, X. X., Cohen, R. E. and Rubner M. F. Two-level antibacterial coating with both release-killing and contact-killing capabilities. langmuir 22 (2006): 9820-9823.

[58] Malinsky, M. D., Kelly, K. L., Schatz, G. C. and Van Duyne, R. P. Nanosphere lithography: effect of substrate on the localized surface plasmon resonance spectrum of silver nanoparticles. J. Phys. Chem. B 105 (2001): 2343–2350.

[59] Foss, C. A., Hornyak, G. L., Stockert, J. A. and Martin, C. R. Optical properties of composite membranes containing arrays of nanoscopic gold cylinders. J. Phys. Chem. 96 (1992): 7497–7499.

[60] Foss, C. A. , Hornyak, G. L., Stockert, J. A. and Martin, C. R. Template-synthesized nanoscopic gold particles: optical spectra and the effects of particle size and shape. J. Phys. Chem. 98 (1994): 2963–2971.

[61] Leuvering, J. H., Thal, P. J., van der Waart, M. and Schuurs, A. H. Sol particle immunoassay (SPIA). J. Immunoassay 1 (1980): 77–91.

[62] Leuvering, J. H., Thal, P. J., van der Waart, M. and Schuurs, A. H. A sol particle agglutination assay for human chorionic gonadotrophin. J. Immunol. Methods 45 (1981): 183–194.

[63] Leuvering, J. H., Goverde, B. C., Thal, P. J. and Schuurs, A. H. A homogeneous sol particle immunoassay for human chorionic gonadotrophin using monoclonal antibodies. J. Immunol. Methods 60 (1983): 9–23.

[64] Leuvering, J. H., Thal, P. J. and Schuurs, A. H. Optimization of a sandwich sol particle immunoassay for human chorionic gonadotrophin. J. Immunol. Methods 62 (1983): 175–184.

[65] Leuvering, J. H., Thal, P. J., White, D. D. and Schuurs, A. H. A homogeneous sol particle immunoassay for total oestrogens in urine and serum samples. J. Immunol. Methods 62 (1983): 163–174.

[66] Gribnau, T. C., Leuvering, J. H. and van Hell, H. Particle-labelled immunoassays: a review. J. Chromatogr. 376 (1986): 175–189.

[67] Van Erp, R., Gribnau, T. C., Van Sommeren, A. P. and Bloemers, H. P. Application of a sol particle immunoassay to the determination of affinity constants of monoclonal antibodies. J. Immunoassay 12 (1991): 425–443.

[68] Elghanian R., Storhoff J. J., Mucic R. C., Letsinger R. L. and Mirkin C. A. Selective colorimetric detection of polynucleotides based on the distance-dependent optical properties of gold nanoparticles. Science 277 (1997): 1078–1081.

[69] Storhoff, J. J., Elghanian, R., Mucic, R. C., Mirkin, C. A., and Letsinger R. L. One-pot colorimetric differentiation of polynucleotides with single base imperfections using gold nanoparticle probes. J. Am. Chem. Soc. 120 (1998): 1959–1964.

[70] Englebienne, P., Van Hoonacker, A., and Valsamis, J. Rapid homogeneous immunoassay for human ferritin in the Cobas mira using colloidal gold as the reporter reagent. Clin. Chem. 46 (2000): 2000–2003.

[71] Underwood, S., and Mulvaney, P. Effect of the solution refractive index on the color of gold colloids. Langmuir 10 (1994): 3427–3430.

[72] Chumanov, G., Sokolov, K., Gregory, B. W., and Cotton, T. M. Colloidal metal films as a substrate for surface-enhanced spectroscopy. J. Phys. Chem. 99 (1995): 9466–9471.

[73] Jensen, T. R., Duval, M. L., Kelly, K. L., Lazarides, A. A., Schatz, G. C., and Van Duyne, R. P. Nanosphere lithography: effect of the external dielectric medium on the surface plasmon resonance spectrum of a periodic array of silver nanoparticles. J. Phys. Chem. B 103 (1999): 9846–9853.

[74] Kelly K.L., Coronado E., and Zhao L.L. The optical properties of metal nanoparticles: The influence of size, shape, and dielectric environment. J Phys Chem B 107 (2003): 668-677.

[75] Perez-Juste J., Pastoriza-Santos I., Liz-Marzan L.M. and Mulvaney P. Gold nanorods: Synthesis, characterization and applications. Coordin Chem Rev 249 (2005): 1870-1901.

[76] Decher, G., Eckle, M., Schmitt, J. and Struth, B. Layer-by-layer assembled multicomposite films. Current Opinion in Colloid & Interface Science 3 (1998): 32-39.

[77] Decher G. Fuzzy nanoassemblies: Toward layered polymeric multicomposites. Science 277 (1997): 1232-1237.

[78] Dubas S.T., and Schlenoff J.B. Factors controlling the growth of polyelectrolyte multilayers. Macromolecules 32 (1999): 8153-8160.

[79] Dubas, S. T. and Schlenoff, J. B. Swelling and smoothing of polyelectrolyte multilayers by salt. Langmuir 17 (2001): 7725-7727.

[80] Dubas, S. T., Farhat, T. R. and Schlenoff, J. B. Multiple membranes from "true" polyelectrolyte multilayers. Journal of the American Chemical Society 123 (2001): 5368-5369.

[81] Dubas, S. T. and Schlenoff, J. B. Polyelectrolyte multilayers containing a weak polyacid: Construction and deconstruction. Macromolecules 34 (2001): 3736-3740.

[82] Schlenoff, J. B., Dubas, S. T. and Farhat, T. Sprayed polyelectrolyte multilayers. Langmuir 16 (2000): 9968-9969.

[83] Dobrynin, A. V. and Rubinstein, M. Theory of polyelectrolytes in solutions and at surfaces. Progress in Polymer Science 30 (2005): 1049-1118.

[84] Picart, C., Lavalle, P., Richert, L., Schaff, P. and Voegel, J. C. Diffusion in polyelectrolyte multilayered films: experiments and theory. Biophysical Journal 84 (2003): 297-300.

[85] Joanny, J. F. and Castelnovo, M. Theoretical study of polyelectrolyte-multilayer formation. Abstracts of Papers of the American Chemical Society 219 (2000): 510-511.

[86] Roldughin, V. I. Self-assembly of nanoparticles at interfaces. Uspekhi Khimii 73 (2004): 123-156.

[87] Hoda, N. and Kumar, S. Kinetic theory of polyelectrolyte adsorption in shear flow. Journal of Rheology 51 (2007): 799-820.

[88] Schlenoff, J. B. and Dubas, S. T. Mechanism of polyelectrolyte multilayer growth: Charge overcompensation and distribution. Macromolecules 34 (2001): 592-598.

[89] Hammond P.T. Recent explorations in electrostatic multilayer thin film assembly. Curr Opin Colloid In 4 (1999): 430-442.

[90] Liu, Z. L., Wang, X. D., Wu, H. Y. and Li, C. X. Silver nanocomposite layer-by-layer films based on assembled polyelectrolyte/dendrimer. Journal of Colloid and Interface Science 287 (2005): 604-611.

[91] Jaber, J. A. and Schlenoff, J. B. Recent developments in the properties and applications of polyelectrolyte multilayers. Curr Opin Colloid In 11 (2006): 324-329.

[92] Dubas, S. T., Chutchawatkulchai, E., Egkasit, S., Lamsamai, C. and Potiyaraj, P. Deposition of polyelectrolyte multilayers to improve the color fastness of silk. Textile Research Journal 77 (2007): 437-441.

[93] Dubas, S. T., Kumlangdudsana, P. and Potiyaraj, P. Layer-by-layer deposition of antimicrobial silver nanoparticles on textile fibers. Colloids and Surfaces A-Physicochemical and Engineering Aspects 289 (2006): 105-109.

[94] Potisatityuenyong, A., Tumcharern, G., Dubas, S. T. and Sukwattanasinitt, M. Layer-by-layer assembly of intact polydiacetylene vesicles with retained

chromic properties. Journal of Colloid and Interface Science 304 (2006): 45-51.

[95] Dubas, S. T., Iamsamai, C. and Potiyaraj, P. Optical alcohol sensor based on dye-Chitosan polyelectrolyte multilayers. Sensors and Actuators B-Chemical 113 (2006): 370-375.

[96] Chen, X., and Schluesenera, H. J., Nanosilver : A nanoproduct in medical application. Toxicology Letters 176 (2008): 1-12.

[97] Kato, N. and Caruso, F. Homogeneous, competitive fluorescence quenching immunoassay based on gold nanoparticle/polyelectrolyte coated latex particles. Journal of Physical Chemistry B 109 (2005): 19604-19612.

[98] Seydack, M. Nanoparticle labels in immunosensing using optical detection methods. Biosensors & Bioelectronics 20 (2005): 2454-2469.

[99] Pavoor, P. V., Gearing, B. P., Gorga, R. E., Bellare, A. and Cohen, R. E. Engineering the friction-and-wear behavior of polyelectrolyte multilayer nanoassemblies through block copolymer surface capping, metallic nanoparticles, and multiwall carbon nanotubes. Journal of Applied Polymer Science 92 (2004): 439-448.

[100] Tang Z.Y., Wang Y., and Podsiadlo P. Biomedical applications of layer-by-layer assembly: From biomimetics to tissue engineering. Adv Mater 18 (2006): 3203-3224.

[101] Wang T.C., Rubner M.F., and Cohen R.E. Polyelectrolyte multilayer nanoreactors for preparing silver nanoparticle composites: Controlling metal concentration and nanoparticle size. Langmuir 18 (2002): 3370-3375.

[102] Logar, M., Jancar, B., Suvorov, D. and Kostanjsek, R. In situ synthesis of Ag nanoparticles in polyelectrolyte multilayers. Nanotechnology 18 (2007): 445-450.

[103] Wang, T. C., Rubner, M. F. and Cohen, R. E. Manipulating nanoparticle size within polyelectrolyte multilayers via electroless nickel deposition. Chemistry of Materials 15 (2003): 299-304.

[104] Lee, I. S., Hammond, P. T. and Rubner, M. F. Selective electroless nickel plating of particle arrays on polyelectrolyte multilayers. Chemistry of Materials 15 (2003): 4583-4589.

[105] Dai, J. H. and Bruening, M. L. Catalytic nanoparticles formed by reduction of metal ions in multilayered polyelectrolyte films. Nano Letters 2 (2002): 497-501.

[106] Wang, T. C., Rubner, M. F. and Cohen, R. E. Polyelectrolyte multilayer nanoreactors for preparing silver nanoparticle composites: Controlling metal concentration and nanoparticle size. Langmuir 18 (2002): 3370-3375.

[107] Joly, S., Kane, R., Radzilowski, L., Wang, T., Wu, A., Cohen, R. E., Thomas, E. L. and Rubner, M. F. Multilayer nanoreactors for metallic and semiconducting particles. Langmuir 16 (2000): 1354-1359.

[108] Gittins D.I., and Caruso F. Tailoring the polyelectrolyte coating of metal nanoparticles. J Phys Chem B 105 (2001): 6846-6852.

[109] Chapman R., and Mulvaney P. Electro-optical shifts in silver nanoparticle films. Chem Phys Lett 349 (2001): 358-362.

[110] Lu, C. H., Bai, S., Zhang, D. B., Huang, L., Ma, J. M., Luo, C. Q. and Cao, W. X. Stable multilayer ultrathin film containing covalently attached colloidal Ag nanoparticles. Nanotechnology 14 (2003): 680-683.

[111] Mayya, K. S., Schoeler, B. and Caruso, F. Preparation and organization of nanoscale polyelectrolyte-coated gold nanoparticles. Advanced Functional Materials 13 (2003): 183-188.

[112] Schuetz, P. and Caruso, F. Electrostatically assembled fluorescent thin films of rare-earth-doped lanthanum phosphate nanoparticles. Chemistry of Materials 14 (2002): 4509-4516.

[113] Kidambi, S. and Bruening, M. L. Multilayer polyelectrolyte films containing silver nanoparticles as anti-bacterial coatings. Abstracts of Papers of the American Chemical Society 231 (2006): 334-340.

[114] Nolte, A. J., Rubner, M. F. and Cohen, R. E. Creating effective refractive index gradients within polyelectrolyte multilayer films: Molecularly assembled rugate filters. Langmuir 20 (2004): 3304-3310.

[115] Jiang, C. Y., Markutsya, S. and Tsukruk, V. V. Collective and individual plasmon resonances in nanoparticle films obtained by spin-assisted layer-by-layer assembly. Langmuir 20 (2004): 882-890.

[116] Sukhorukov, G. B., Mohwald, H., Decher, G. and Lvov, Y. M. Assembly of polyelectrolyte multilayer films by consecutively alternating adsorption of polynucleotides and polycations. Thin Solid Films 285 (1996): 220-223.

[117] Lvov, Y., Essler, F. and Decher, G. Combination of Polycation Polyanion Self-Assembly and Langmuir-Blodgett Transfer for the Construction of Superlattice Films. Journal of Physical Chemistry 97 (1993): 13773-13777.

[118] Lvov, Y., Decher, G. and Sukhorukov, G. Assembly of Thin-Films by Means of Successive Deposition of Alternate Layers of Dna and Poly(Allylamine). Macromolecules 26 (1993): 5396-5399.

[119] Jiang, G. Q., Baba, A., Ikarashi, H., Xu, R. S., Locklin, J., Kashif, K. R., Shinbo, K., Kato, K., Kaneko, F. and Advincula, R. Signal enhancement and tuning of surface plasmon resonance in Au nanoparticle/polyelectrolyte ultrathin films. Journal of Physical Chemistry C 111 (2007): 18687-18694.

[120] Ray, K., Badugu, R. and Lakowicz, J. R. Polyelectrolyte layer-by-layer assembly to control the distance between fluorophores and plasmonic nanostructures. Chemistry of Materials 19 (2007): 5902-5909.

[121] Boker, A., He, J., Emrick, T. and Russell, T. P. Self-assembly of nanoparticles at interfaces. Soft Matter 3 (2007): 1231-1248.

[122] Radziuk, D., Skirtach, A., Sukhorukov, G., Shchukin, D. and Mohwald, H. Stabilization of silver nanoparticles by polyelectroliftes and poly(eithylene glycol). Macromolecular Rapid Communications 28 (2007): 848-855.

[123] Salgueirino-Maceira, V., Correa-Duarte, M. A., Lopez-Quintela, M. A. and Rivas, J. Surface plasmon resonance in gold/magnetite nanoparticulated layers onto planar substrates. Sensor Letters 5 (2007): 113-117.

[124] dos Santos, D. S. and Aroca, R. F. Selective surface-enhanced fluorescence and dye aggregation with layer-by-layer film substrates. Analyst 132 (2007): 450-454.

[125] Jiang, C. Y., Markutsya, S., Pikus, Y. and Tsukruk, V. V. Freely suspended nanocomposite membranes as highly sensitive sensors. Nature Materials 3 (2004): 721-728.

[126] Kotov, N. A., Dekany, I. and Fendler J. H. layer-by-layer self-assembly of polyelectrolyte-semiconductor nanoparticle composite films. Journal of Physical Chemistry 99 (1995): 13065-13069.

[127] Nath, N. and Chilkoti, A. Label-free biosensing by surface plasmon resonance of nanoparticles on glass: Optimization of nanoparticle size. Analytical Chemistry 76 (2004): 5370-5378.

[128] Schuetz, P. and Caruso, F. Semiconductor and metal nanoparticle formation on polymer spheres coated with weak polyelectrolyte multilayers. Chemistry of Materials 16 (2004): 3066-3073.

[129] Carrara, M., Kakkassery, J. J., Abid, J. P. and Fermin, D. J. Modulation of the work function in layer-by-layer assembly of metal nanoparticles and poly-L-lysine on modified Au surfaces. Chemphyschem 5 (2004): 571-575.

[130] Mayya, K. S., Schoeler, B. and Caruso, F. Preparation and organization of nanoscale polyelectrolyte-coated gold nanoparticles. Advanced Functional Materials 13 (2003): 183-188.

[131] Malikova, N., Pastoriza-Santos, I., Schierhorn, M., Kotov, N. A. and Liz-Marzan, L. M. Layer-by-layer assembled mixed spherical and planar gold nanoparticles: Control of interparticle interactions. Langmuir 18 (2002): 3694-3697.

[132] Gittins, D. I. and Caruso, F. Tailoring the polyelectrolyte coating of metal nanoparticles. Journal of Physical Chemistry B 105 (2001): 6846-6852.

[133] Sastry, M., Kumar, A., Datar, S., Dharmadhikari, C. V. and Ganesh, K. N. DNA-mediated electrostatic assembly of gold nanoparticles into linear arrays by a simple drop-coating procedure. Applied Physics Letters 78 (2001): 2943-2945.

[134] ejandro-Arellano, M., Ung, T., Blanco, A., Mulvaney, P. and Liz-Marzan, L. M. Silica-coated metals and semiconductors. Stabilization and nanostructuring. Pure and Applied Chemistry 72 (2000): 257-267.

[135] Xiong, H. M., Zhou, Z., Wang, Z. Q., Zhang, X. and Shen, J. C. A new approach to fabrication of a self-organizing film of heterostructured polymer/CdS nanoparticles. Supramolecular Science 5 (1998): 623-626.

[136] Chen, H., Wang, Y. and Dong, S. An effective hydrothermal route for the synthesis of multiple PDDA-protected noble-metal nanostructures. Inorganic Chemistry 46 (2007): 10587-10593.

[137] Maheshwari, V. and Saraf, R. F. High-resolution thin-film device to sense texture by touch. Science 312 (2006): 1501-1504.

[138] Bucur, C. B., Sui, Z. and Schlenoff, J. B. Ideal mixing in polyelectrolyte complexes and multilayers: Entropy driven assembly. Journal of The American Chemical Society 128 (2006): 13690-13691.

[139] Rmaile, H. H. and Schlenoff, J. B. "Internal pK(a)'s" in polyelectrolyte multilayers. Langmuir 18 (2002): 8263-8265.

[140] Xu, H. X. and Kall, M. Modeling the optical response of nanoparticle-based surface plasmon resonance sensors. Sensors and Actuators B-Chemical 87 (2002): 244-249.

[141] Stanton, B. W., Harris, J. J., Miller, M. D. and bruening, M. L. Ultrathin, multilayered polyelectrolyte films as nanofiltration membranes. Langmuir 19 (2003): 7038-7042.

[142] Burnham, N.A. and Colton, R.J. Measuring the nanomechanical properties and surface forces of materials using an atomic force microscope. J. Vac. Sci. Technol. 7 (1989), 2906-2913.

BIOGRAPHY

Mr. Stephan Thierry Dubas

Born in Marseille, France on august 21st 1973

EDUCATION

1996	Master in Science, Fluid Mechanics, University of Provence, Marseille, France.
1998	Master in Engineering, Material science, Mines School of Ales, France.

EXPERIENCE

1997	Project Engineer and Consultant for "IDETEC engineering", France
1998 – 2004	Research associate in the department of chemistry and biochemistry at Florida State
2001-2004	R&D manager for Nanostrata Inc. Florida, USA.

CURRENT POSITION

2004-present	Researcher in the polymer division of the Metallurgy and material science research institute (MMRI) Chulalongkorn University with a focus on nanomaterials.

SELECTED PUBLICATIONS

- Dubas ST, Pimpan V, Green Synthesis of Silver nanoparticles for Ammonia Sensing, TALANTA, (in press, 2008)
- Dubas ST, Iamsamai C, Potiyaraj P Optical alcohol sensor based on dye-Chitosan polyelectrolyte multilayers SENSORS AND ACTUATORS B-CHEMICAL 113 (1): 370-375 JAN 17 2006
- Dubas ST, Farhat TR, Schlenoff JB Multiple membranes from "true" polyelectrolyte multilayers JOURNAL OF THE AMERICAN CHEMICAL SOCIETY 123 (22): 5368-5369 JUN 6 2001

487 38551 23 : MAJOR MATERIALS SCIENCE

KEY WORD: SILVER / NANOPARTICLES / LAYER-BY-LAYER / SENSORS / FILMS

Mr. STEPHAN THIERRY DUBAS : PREPARATION OF SILVER NANOPARTICLE THIN FILMS FOR SENSING APPLICATIONS. THESIS ADVISOR: ASSOCIATE PROFESSOR VIMOLVAN PIMPAN, Ph.D., 131 pp.

Silver nanoparticles were prepared by the reduction of silver nitrate with sodium borohydride in the presence of a polyelectrolyte acting as a capping agent. Different polyelectrolytes were used including poly(methacrylic acid, sodium salt), poly(acrylic acid, sodium salt), poly(4-styrene sulfonic acid-*co*-maleic acid, sodium salt), sodium alginate and humic acid. Their concentrations were varied from 0.1, 0.5, 1, 5 and 10 mM. All prepared solutions exhibited a strong plasmon band at the wavelength of 400 nm confirming the formation of silver nanoparticles. Layer-by-layer technique was used to deposit silver nanoparticles into thin films. The growth of these films was affected by the dipping time, the dilution and the ionic strength of the solution. Nanoindentation measurements revealed that the film hardness decreased when lower concentrations of capping agents were used in the preparation of the silver nanoparticles.

Sensing properties of silver nanoparticles were then investigated in the forms of solution and thin film. It was found that only nanoparticles prepared in the presence of 0.1 mM of capping agents could be used for organic compound sensing. It was also observed that at this concentration, alginate-capped silver nanoparticle solution had the highest sensitivity to organic compounds while its thin film displayed a strong color shift from yellow in water to red in methanol and ethanol. The best detection was achieved when the ratio of alginate:silver nitrate was 0.1:1. In the case of herbicide sensing, it was found that the color of humic acid-capped silver nanoparticle solution changed from yellow to orange red and purple with increasing herbicide concentration. Furthermore, an improvement of the sensing sensitivity of the film could be done by the modification of film surface with a layer of polycationic polymer.

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