

## **„Das PEEK Implantat als Alternative zum Titan“**

**Autor:** Dr. Armin Nedjat

*Dental Tribune Deutschland, Österreich, Schweiz - 10/2014*

### **Literatur**

- 1) Hypersensitivity to titanium: Clinical and laboratory evidence; Neuroendocrinology letters Vol 27 2006. Kurt Müller. & Elizabeth Valentine-Thon.
- 2) Allergies et intolérances en implantologie. Mémoire de l'attestation d'étude et de recherches approfondies en implantologie orale. Dr EPPE 2006.
- 3) Processing and tensile properties of hydroxyapatite- whisker-reinforced Polyetheretherketone. Gabriel L. Converse, Weimin Yue, Ryan K. Roeder. Biomaterial 28 (2007).
- 4) Early changes in the cervical foramina area after anterior interbody fusion with polyetheretherketone (PEEK) cage containing synthetic bone particulate: a prospective study of 20 cases. Sekerci Z, Ugur A, Ergun R, Sanli M. PMID 16808891 2006 Jul.
- 5) In vitro apatite formation and its growth kinetics on hydroxyapatite/polyetheretherketone biocomposites. Shucong Yu, Kithva Prakash Hariman, Rajendra Kumar, Philip Cheang, Khor KhiamAik. Biomaterial 26(2005).
- 6) A new biocompatible biomaterial: PEEK/B-TCP/TiO<sub>2</sub> composite. M-F Harmand, JP-Cougoulic. Faenza Congress 2005.
- 7) Fabrication and characterization of three-dimensional poly(ether-ether-ketone)/-hydroxyapatite biocomposite scaffolds using laser sintering. PMID: 1593494 2005 May.
- 8) Response of primary fibroblasts and osteoblasts to plasma treated polyetheretherketone(PEEK) surfaces. PMID: 15965600 2005 Jul.
- 9) In vitro apatite formation and its growth kinetics on hydroxyapatite Polyetheretherketone biocomposites. Shucong Yu, Kithva Prakash Hariman, Rajendra Kumar, Philip Cheang, Khor Khiam Aik. Biomaterial 26 (2005).
- 10) A new biocompatible biomaterial: PEEK/B-TCP/TiO<sub>2</sub> composite. M-F Harmand, JP-Cougoulic. Sydney 9WBC Congress 2004.
- 11) Modeling of the mechanical behavior of HA/PEEK biocomposite under quasi-static tensile load. J.P. FAN, C.P Tsui, C.Y. Tang.
- 12) Materials Science and Engineering A 382 (2004) Tension- tension fatigue behavior of hydroxyapatite reinforced polyetheretherketone composites. S.M. Tang, P. Cheang, M.S. AbuBakar, K.A. Khor, K. Liao. International Journal of Fatigue 26(2004) 49-57.
- 13) Improving Human Primary Osteoblast Interactions to PEEK by Surface Modification, Poulsson, A.H.C; Richards, R.G., AO Research Institute, Davos, CH.; Cardiff School of Biosciences; Poster No. 1315 ORS 2011 Annual Meeting.
- 14) Le Biopik®: La prothèse fixée dento-implanto portée désormais fiable grâce aux propriétés physiques d'un nouveau matériau.

- 15) Co-culture Adhesion of Bacteria and Osteoblasts to Oxygen Plasma Treated PEEK  
1,2Rochford E.T.J; 3Subbiahdoss G.; 1Moriarty T.F.; +1Poulsson A.H.C; 3van der Mei  
H.C.; 3Busscher H.J.; 1,2Richards R.G. 1AO Research Institute, CH. 2IBERS, Aberystwyth  
University, UK. 3University Medical Center Groningen and University of Groningen, NL; Poster  
No. 1559 ORS 2011 Annual Meeting.
- 16) A new biocompatible biomaterial: PEEK /  $\beta$ -TCP / TiO<sub>2</sub> composite, M.-F. HARMAND (1)  
(2) - J.-P COUGOULIC (1) (1) LEMI – Technopole Montesquieu – 33650 MARTILLAC –  
FRANCE – lemi@atlantel.fr (2) DETERCA – University of Bordeaux 2 – 33076 BORDEAUX –  
FRANCE.
- 17) In vitro biocompatibility of polyetheretherketone and polysulfone composites; Wenz LM.,  
Merritt K., Brown SA., Moet A., Steffee AD. J. Biomed. Mater. Res. 1990; 24(2): 207-215.
- 18) Polyetheretherketone – cytotoxicity and mutagenicity in vitro; Katzer A., Marquardt H.,  
Westendorf J., Wening JV., von Foerster G., Biomaterials, 2002; 23(8): 1749-1759.
- 19) Composite technology in load-bearing orthopaedic implants, Evans SL., Gregson PJ.  
Biomaterials, 1998; 19(15): 1329-1342.
- 20) Feasibility of knitted carbon/PEEK composites for orthopaedic bone plates. Fujihara K.,  
Huang ZM., Ramakrishna S., Satknanantham K., Hamada H.; Biomaterials, 2004; 25(17): 3877-  
3885.
- 21) Thermal analysis studies of poly(etheretherketone)/hydroxyapatite biocomposite mixtures;  
Meenan BJ., McClorey C., Akay M. J Mater Sci Mater Med. 2000; 11(8): 481-489.
- 22) Tensile properties, tension-tension fatigue and biological response of  
polyetheretherketonehydroxyapatite composites for load-bearing orthopaedic implants; Abu Bakar  
MS., Cheng MH., Tang SM., Yu SC., Liao K., Tan CT., Khor KA., Cheang P. Biomaterials, 2003;  
24(13): 2245-2250.
- 23) Scaffold development using selective laser sintering of polyetheretherketone-hydroxyapatite  
biocomposite blends; Tan KH., Chua CK., Leong KF., Cheah CM., Cheang P., Abu Bakar MS.,  
Cha SW. Biomaterials, 2003; 24(18): 3115-3123.
- 24) Cytocompatibility of two coating materials, amorphous alumina and silicon carbide, using  
human differentiated cell cultures. Naji A., Harmand MF. Biomaterials, 1991; 12(7): 690-694.
- 25) Biochemicals characterization with parathormone and calcitonin of isolated bone cells:  
provisional identification of osteoclasts and osteoblasts; Luben RA., Wong GL., Cohn DV.  
Endocrinology. 1976; 99(2): 526-534.
- 26) Ca<sup>2+</sup> as an extracellular signal in bone; Dvorak MM., Riccardi D. Cell Calcium. 2004; 35(3):  
249-255.
- 27) Involvement of calciumsensing receptor (CaR) in osteoblastic differentiation of mouse  
MC3T3-E1 cells; Yamauchi M., Yamaguchi T., Kaji H. Sugimoto T., Chihara K. Am J Physiol  
Endocrinol Metab. 2004 Nov 16. [Epub ahead of print].
- 28) Mitogenic action of calcium-sensing receptor on rat calvarial osteoblasts. Endocrinology.  
2004 ; 145(7) : 3451-3462; Chattopadhyay N., Yano S., Tfelt-Hansen J., Rooney P., Kanuparthi  
D., Bandyopadhyay S., Ren X., Terwilliger E., Brown EM.

- 29) Physiological changes in extracellular calcium concentration directly control osteoblast function in the absence of calciotropic hormones; Dvorak MM., Siddiqua A., Ward DT., Carter DH., Dallas SL., Nemeth EF., Riccardi D., Proc Natl Acad Sci USA. 2004; 101(14): 5140-5145.
- 30) Customised Implants for Bone Replacement and Growth; Liang Hao and Russell Harris, Book Chapter 6.
- 31) Bone tissue engineering: State of the art and future trends; Salgado, A. J., Coutinho, O. P. and Reis, R. L. (2004). *Macromolecular Bioscience*, 4(8), 743-765.
- 32) Osseointegration and its experimental background; Branemark, P. I. (1983). *Journal of Prosthetic Dentistry*, 50(3), 399-410.
- 33) Selective laser sintering of ultra high molecular weight polyethylene for clinical applications; Rimell, J. T. and Marquis, P. M. (2000). *J. Biomed. Mater. Res.* 53(4), 414-420.
- 34) Medical rapid prototyping applications and methods. Hieu, L. C., Zlatov, N., Sloten, J. V., Bohez, E., Khanh, L., Binh, P. H., Oris, P. and Toshev, Y. (2005). *Assembly Automation*, 25(4), 284-292.
- 35) *Clinically Oriented Anatomy*, Moore, K. L. and Dalley, A. F. (1999). Lippincott Williams & Wilkins, Maryland.
- 36) Biomaterials in total joint replacement. *Colloids and Surfaces; B* Katti, K. S. (2004): *Biointerfaces*, 39(3), 133-142.
- 37) *Handbook of Materials for Medical Devices*; Davis, J. R. (2003). ASM International.
- 38) Engineering craniofacial scaffolds; Hollister, S. J., Lin, C. Y., Saito, E., Lin, C. Y., Schek, R. D., Taboas, J. M., Williams, J. M., Partee, B., Flanagan, C. L., Diggs, A., Wilke, E. N., Van Lenthe, G. H., Muller, R., Wirtz, T., Das, S., Feinberg, S. E. and Krebsbach, P. H. (2005). *Orthodontic Craniofacial Research*, 8, 162-173.
- 39) Solid freeform fabrication of threedimensional scaffolds for engineering replacement tissues and organs; Leong, K. F., Cheah, C. M. and Chua, C. K. (2003). *Biomaterials*, 24(13), 2363-2378.
- 40) Scaffold-based tissue engineering: rationale for computer-aided design and solid free-form fabrication systems; Huttmacher, D. W., Sittinger, M. and Risbud, M. V. (2004). *Trends in Biotechnology*, 22(7), 354-362.
- 41) Mediation of bone ingrowth in porous hydroxyapatite bone graft substitutes; Hing, K. A., Best, S. M., Tanner, K. E., Bonfield, W. and Revell, P. A. (2004). *J. Biomed. Mater. Res. Part A*, 68A(1), 187-200.
- 42) Biodegradable and bioactive porous polymer/inorganic composite scaffolds for bone tissue engineering; Rezwan, K., Chen, Q. Z., Blaker, J. J. and Boccaccini, A. R. (2006). *Biomaterials*, 27(18), 3413-3431.
- 43) Set to Revolutionise Medical Device Manufacture; Hedges, M. (2003). *Lens™ Technology*, [www.opnews.com/articles/126.sep.2003/articles.php](http://www.opnews.com/articles/126.sep.2003/articles.php).
- 44) [www.optomec.com](http://www.optomec.com).

- 45) Computational design, freeform fabrication and testing of Nylon-6 tissue engineering scaffolds; Das, S., Hollister, S. J., Flanagan, C., Adewunmi, A., Bark, K., Chen, C., Ramaswamy, K., Rose, D. and Widjaja, E. Rapid Prototyping Technologies, Dec. 3-5 2002, Boston, MA, United States, 205-210.
- 46) Bone tissue engineering using polycaprolactone scaffolds fabricated via selective laser sintering; Williams, J. M., Adewunmi, A., Schek, R. M., Flanagan, C. L., Krebsbach, P. H., Feinberg, S. E., Hollister, S. J. and Das, S. (2005). *Biomaterials*, 26(23), 4817-4827.
- 47) Selective laser sintering process optimization for layered manufacturing of CAPA (R) 6501 polycaprolactone bone tissue engineering scaffolds; Partee, B., Hollister, S. J. and Das, S. (2006). *Journal of Manufacturing Science and Engineering-Transactions of the Asme*, 128(2), 531-540.  
104 L. Hao, R. Harris
- 48) Biocompatibility of SLS-formed calcium phosphate implants; Lee, G., Barlow, J. W., Fox, W. C. and Aufdermorte, T. B. (1996) *Proceedings of Solid Freeform Fabrication Symposium*, Austin, TX, 15-22. 12-14th August, 1996.
- 49) Materials for biomedical applications; Vail, N. K., Swain, L. D., Fox, W. C., Aufdermorte, T. B., Lee, G. and Barlow, J. W. (1999). *Materials & Design*, 20(2-3), 123-132.

- 50) Scaffold development using selective laser sintering of polyetheretherketone-hydroxyapatite biocomposite blends; Tan, K. H., Chua, C. K., Leong, K. F., Cheah, C. M., Cheang, P., Abu Bakar, M. S. and Cha, S. W. (2003). *Biomaterials*, 24(18), 3115-3123.
- 51) Fabrication and characterization of three-dimensional poly(ether-ether-ketone)/-hydroxyapatite biocomposite scaffolds using laser sintering; Tan, K. H., Chua, C. K., Leong, K. F., Naing, M. W. and Cheah, C. M. (2005). *Proceedings of the Institution of Mechanical Engineers Part H-Journal of Engineering in Medicine*, 219(H3), 183-194.
- 52) Development of tissue scaffolds using selective laser sintering of polyvinyl alcohol/hydroxyapatite biocomposite for craniofacial and joint defects; Chua, C. K., Leong, K. F., Tan, K. H., Wiria, F. E. and Cheah, C. M. (2004). *Journal of Materials Science: Materials in Medicine*, 15(10), 1113-1121.
- 53) Direct manufacturing of hydroxyapatite based bone implants by selective laser sintering; Cruz, F., Simoes, J., Coole, T. and Bucking, T. (2005) 2nd International Conference on Advanced Research in Virtual and Rapid Prototyping, Leiria, Portugal.
- 54) Customisation of bio-ceramic implants using SLS; Coole, T., Cruz, F., Simoes, J. and Bocking, C. (2005). *Virtual Modeling and Rapid Manufacturing – Advanced Research in Virtual and Rapid Prototyping*, Taylor & Francis Group, 147-151.
- 55) Selective laser sintering of hydroxyapatite reinforced polyethylene composites for bioactive implants and tissue scaffold development; Hao, L., Savalani, M. M., Zhang, Y., Tanner, K. E. and Harris, R. A. (2006). *Proceedings of the Institution of Mechanical Engineers Part H-Journal of Engineering in Medicine*, 220(H4), 521-531.
- 56) Evaluation of CO<sub>2</sub> and Nd : YAG lasers for the selective laser sintering of HAPEX (R); Savalani, M. M., Hao, L. and Harris, R. A. (2006). *Proceedings of the Institution of Mechanical Engineers Part B-Journal of Engineering Manufacture*, 220(2), 171-182.
- 57) The effect of material and processing conditions on characteristics of hydroxyapatite and high density polyethylene bio-composite by selective laser sintering; Hao, L., Savalani, M. M., Zhang, Y., Tanner, K. E. and Harris, R. A. (2006). *Proceedings of the IMechE Part L, Journal of Materials: Design & Application*, Accepted for publication.
- 58) Comparison of direct and indirect selective laser sintering of porous apatite mullite glass ceramics; Goodridge, R. D., Lorrison, J. C., Dalgarno, K. W. and Wood, D. J. (2004). *Glass Technology*, 45(2), 94-96.
- 59) Indirect selective laser sintering of an apatite-mullite glass-ceramic for potential use in bone replacement applications; Goodridge, R. D., Dalgarno, K. W. and Wood, D. J. (2006). *Proceedings of the Institution of Mechanical Engineers Part H-Journal of Engineering in Medicine*, 220(H1), 57-68.
- 60) Selective laser sintering method using titanium powder sheet toward fabrication of porous bone substitutes; Hayashi, T. (2005). *JSME International Journal Series A*, 48(4), 369-375.

- 61) The design and production of Co-Cr alloy implants with controlled surface topography by CAD-CAM method and their effects on osseointegration; Hunt, J. A., Callaghan, J. T., Sutcliffe, C. J., Morgan, R. H., Halford, B. and Black, R. A. (2005). *Biomaterials*, 26(29), 5890-5897.
- 62) Implant design and production – a new approach by selective laser melting; Wehmoller, M., Warnke, P. H., Zilian, C. and Eufinger, H. (2005). *Computer Assisted Radiology and Surgery*, 1281, 690-695.
- 63) Structural, mechanical and in vitro characterization of 6 Customised Implants for Bone Replacement and Growth 105 individually structured Ti-6Al-4V produced by direct laser forming; Hollander, D. A., von Walter, M., Wirtz, T., Sellei, R., Schmidt-Rohlfing, B., Paar, O. and Erli, H.-J. (2006). *Biomaterials*, 27(7), 955-963.
- 64) Fused deposition modeling of novel scaffold architectures for tissue engineering applications; Zein, I., Hutmacher, D. W., Tan, K. C. and Teoh, S. H. (2002). *Biomaterials*, 23(4), 1169-1185.
- 65) Osteogenic induction of human bone marrow-derived mesenchymal progenitor cells in novel synthetic polymer-hydrogel matrices; Endres, M., Hutmacher, D. W., Salgado, A. J., Kaps, C., Ringe, J., Reis, R. L., Sittering, M., Brandwood, A. and Schantz, J. T. (2003). *Tissue Engineering*, 9(4), 689-702.
- 66) The effect of rhBMP-2 on canine osteoblasts seeded onto 3D bioactive polycaprolactone scaffolds; Rai, B., Teoh, S. H., Ho, K. H., Hutmacher, D. W., Cao, T., Chen, F. and Yacob, K. (2004). *Biomaterials*, 25(24), 5499-5506.
- 67) Evaluation of a hybrid scaffold/cell construct in repair of high-load-bearing osteochondral defects in rabbits; Shao, X. X., Hutmacher, D. W., Ho, S. T., Goh, J. C. H. and Lee, E. H. (2006). *Biomaterials*, 27(7), 1071-1080.
- 68) Rapid prototyping in tissue engineering: challenges and potential; Yeong, W.-Y., Chua, C.-K., Leong, K.-F. and Chandrasekaran, M. (2004). *Trends in Biotechnology*, 22(12), 643-652.
- 69) Precision extruding deposition and characterization of cellular poly-epsilon-caprolactone tissue scaffolds; Wang, F., Shor, L., Darling, A., Khalil, S., Sun, W., Guceri, S. and Lau, A. (2004). *Rapid Prototyping Journal*, 10(1), 42-49.
- 70) Fabrication of porous poly (L-lactic acid) scaffolds for bone tissue engineering via precise extrusion; Xiong, Z., Yan, Y. N., Zhang, R. J. and Sun, L. (2001). *Scripta Materialia*, 45(7), 773-779.
- 71) Fabrication of porous scaffolds for bone tissue engineering via low-temperature deposition; Xiong, Z., Yan, Y. N., Wang, S. G., Zhang, R. J. and Zhang, C. (2002). *Scripta Materialia*, 46(11), 771-776.

- 72) Layered manufacturing of tissue engineering scaffolds via multi-nozzle deposition; Yan, Y. N., Xiong, Z., Hu, Y. Y., Wang, S. G., Zhang, R. J. and Zhang, C. (2003). *Materials Letters*, 57(18), 2623-2628.
- 73) Rapid prototyping of scaffolds derived from thermoreversible hydrogels and tailored for applications in tissue engineering; Landers, R., Hubner, U., Schmelzeisen, R. and Mulhaupt, R. (2002). *Biomaterials*, 23(23), 4437-4447.
- 74) Fabrication of soft tissue engineering scaffolds by means of rapid prototyping techniques; Landers, R., Pfister, A., Hubner, U., John, H., Schmelzeisen, R. and Mulhaupt, R. (2002) *Journal of Materials Science*, 37(15), 3107-3116.
- 75) Fabrication of soft and hard biocompatible scaffolds using 3D-Bioplotting (TM); Carvalho, C., Landers, R., Mulhaupt, R., Hubner, U. and Schmelzeisen, R. (2005)
- 76) Porous Ti6Al4V scaffold directly fabricating by rapid prototyping: Preparation and in vitro experiment; Li, J. P., de Wijn, J. R., Van Blitterswijk, C. A. and de Groot, K. (2006). *Biomaterials*, 27(8), 1223-1235.
- 77) Three dimensional printing. Rapid Tooling and prototypes directly from a CAD model; Sachs, E., Cima, M., Williams, P., Brancazio, D. and Cornie, J. (1992). *Journal of Engineering for Industry, Transactions of the ASME*, 114(4), 481-488.
- 78) A three-dimensional osteochondral composite scaffold for articular cartilage repair; Sherwood, J. K., Riley, S. L., Palazzolo, R., Brown, S. C., Monkhouse, D. C., Coates, M., Griffith, L. G., Landeen, L. K. and Ratcliffe, A. (2002). *Biomaterials*, 23(24), 4739-4751.
- 79) Performance of degradable composite bone repair products made via threedimensional fabrication techniques; Dutta Roy, T., Simon, J. L., Ricci, J. L., Rekow, E. D., Thompson, V. P. and Parsons, J. R. (2003). *J. Biomed. Mater. Res. Part A*, 66(2), 283-291.106 L. Hao, R. Harris
- 80) Three-dimensional printing of porous ceramic scaffolds for bone tissue engineering; Seitz, H., Rieder, W., Irsen, S., Leukers, B. and Tille, C. (2005). *J. Biomed. Mater. Res. Part B Applied Biomaterials*, 74(2), 782-788.
- 81) Ceramic SFF by direct and indirect stereolithography; Chu, G. T. M., Brady, G. A., Miao, W., Halloran, J. W., Hollister, S. J. and Brei, D. (1999) *Solid Freeform and Additive Fabrication: a Materials Research Society Symposium*, Boston, USA, 119-123.
- 82) Hydroxyapatite implants with designed internal architecture; Chu, T.-M. G., Halloran, J. W., Hollister, S. J. and Feinberg, S. E. (2001). *Journal of Materials Science: Materials in Medicine*, 12(6), 471-478.
- 83) Mechanical and in vivo performance of hydroxyapatite implants with controlled architectures; Chu, T.-M. G., Orton, D. G., Hollister, S. J., Feinberg, S. E. and Halloran, J. W. (2002). *Biomaterials*, 23(5), 1283-1293.

- 84) Customized design and manufacturing of chin implant based on rapid prototyping; Singare, S., Dichen, L., Bingheng, L., Zhenyu, G. and Yaxiong, L. (2005). *Rapid Prototyping Journal*, 11(2), 113-118.
- 85) Craniofacial reconstruction with computer-generate HTR patientmatched implants: use in primary bony tumor excision; Eppley, B. L. (2002). *Journal of Craniofacial Surgery*, 13(5), 650-657.
- 86) Shape the implant to the patient. A rationale for the use of customfit cementless total implants; *Clinical Orthopaedics Related Research*, 249, 73-78. Bargar, W. L. (1989).
- 87) Rapid prototypes and customized implants in maxillofacial reconstruction. Peckitt, N. S. (2001), In *Rapid Prototyping Casebook*, Professional Engineering Publications, 191-200.
- 88) Bone tissue engineering: State of the art and future trends; Salgado, A. J., Coutinho, O. P. and Reis, R. L. (2004). *Macromolecular Bioscience*, 4(8), 743-765.
- 89) Effect of bTCP filled polyetheretherketone on osteoblast cell proliferation in vitro; L. Petrovic<sup>1</sup>, D. Pohle<sup>2</sup>, H. Muñstedt<sup>2</sup>, T. Rechtenwald<sup>3</sup>, K. A. Schlegel<sup>1</sup> & S. Rupprecht<sup>1,\*</sup>  
<sup>1</sup>Department of Oral and Maxillofacial Surgery, Friedrich-Alexander-University Erlangen-Nuremberg, Glückstr. 11, 91054, Erlangen, Germany; <sup>2</sup>Department of Materials Science, Institute of Polymer Materials, Friedrich-Alexander-University Erlangen-Nuremberg, Martensstr. 7, 91058, Erlangen, Germany; <sup>3</sup>Bavarian Laser Center, Konrad-Zuse-Str. 2-6, 91052, Erlangen, Germany, Received 19 May 2005; accepted 8 September 2005  
2005 National Science Council, Taipei
- 90) In vivo biocompatibility testing of peek polymer for a spinal implant system: A study in rabbits; Charles-H Rivard, Souad Rhalmi, Christine Coillard Pediatric Research Center, Sainte-Justine Hospital, Montreal, Canada  
Received 8 February 2001; revised 6 November 2001; accepted 20 November 2001
- 91) Preliminary evaluation of titanium- coated PEEK dental implants; Cook SD, Rust-Dawicki AM. *J Oral Implantology* 1995; 21:176-181.
- 92) Biological response to chopped-carbon-fiber-reinforced PEEK; Jockish KA, Brown SA, Bauer TW, Merrit K. *J Biomed Mater* 1992; 26:133-146.
- 93) Biological response to ligament wear particles; Claes LE, Ludwig J, Margevičius KJ, Durselen L. *J Appl Biomater* 1995; 6: 35-41.
- 94) Potential of polyetheretherketone (PEEK) and carbon-fibre-reinforced PEEK in medical applications. William DF, Mcnamara A. *J Mater Science Lett* 1987; 6:188-190.



- 95) In vitro biocompatibility testing of polymers for orthopaedic implants using cultured fibroblasts and osteoblasts. Morrison C, Macnair R, MacDonald C, Wykman A, Goldie I, Grant MH., *Biomaterials*, 1995;16: 987-992.
- 96) In vitro biocompatibility of polyetheretherketone and polysulfone composites. Wenz LM, Merritt K, Brown SA, Moet A, Steffee AD., *J. Biomed. Mater. Res.* 1990; 24: 207-215.
- 97) Van Der Vis HM, Marti RK, Tigchellaar W, Schuller HM, Van Noorden CJF. Benign cellular response in rats to different wear particles in intra-articular and intramedullary environments. *JBJS* 1997; 79-B: 837-843.
- 98) Guide to the Care and Use of Experimental Animals, Canadian Council on Animal Care. 2 vols. Ottawa, Ontario: CCAC; 1980-1984.
- 99) AAMI Standards and Recommendation Practices, Association for the Advancement of Medical Devices (AAMI).  
Volume 4. Biological Evaluation of Medical Devices, Part 6. ANSI/ AAMI/ISO 109993, Edition 1996,m 91.
- 100) American Society for Testing and Materials. Standard Practice of Short-Term Screening of Implant Materials. Annual Book of ASTM Standards, Section 13, Volume 13.01, Medical Devices. ASTM F 763-87. Philadelphia, PA: ASTM; 1992.
- 101) American Society for Testing and Materials. Standard Practice of Assessment of Biocompatibility of Biomaterials (nonporous) for Surgical Implants with Respect to Effect of Materials on Muscle and Bone. Annual Book of ASTM Standards, Section 13, Volume 13.01, Medical Devices. ASTM F 981-91. Philadelphia, PA: ASTM; 1992.
- 102) Turner JE, Lawrence WH, Autian J. Subacute toxicity testing of biomaterials using histopathologic evaluation of rabbit muscle tissue. *J. Biomed. Mater. Res.* 1973; 7: 39-58.  
Cook S.D. and Rust-Dawicki A.M., Preliminary evaluation of titanium-coated PEEK dental implants. *J. Oral Implantol.* 21: 176-181, 1995.
- 103) Goldberg A.J., Burstone C.J., Hadjinikolaou I. and Jancar J., Screening of matrices and fibers for reinforced thermoplastics intended for dental applications. *J. Biomed. Mater. Res.* 28: 167-173, 1994.
- 104) Terjesen T. and Apalset K., The influence of different degrees of stiffness of fixation plates on experimental bone healing. *J. Orthop. Res.* 6: 293-299, 1988.
- 105) Fujihara K., Huang Z.M., Ramakrishna S., Satknanantham K. and Hamada H., Performance study of braided carbon/PEEK composite compression bone plates. *Biomaterials*, 24: 2661-2667, 2003.
- 106) Abu Bakar M.S., Cheng M.H., Tang S.M., Yu S.C., Liao K., Tan C.T., Khor K.A. and Cheang P., Tensile properties, tension-tension fatigue and biological response of polyetheretherketone- hydroxyapatite composites for load-bearing orthopedic implants. *Biomaterials*, 24: 2245-2250, 2003.
- 107) Bohner M., Calcium orthophosphates in medicine: from ceramics to calcium phosphate cements. *Injury* 31(Suppl 4): 37-47, 2000.

- 108) Currey J., Incompatible mechanical properties in compact bone. *J. Theor. Biol.* 231: 569-580, 2004.
- 109) Frayssinet P., Trouillet J.L., Rouquet N., Azimus E. and Autefage A., Osseointegration of macroporous calcium phosphate ceramics having a different chemical composition. *Biomaterials*, 14: 423-429, 1993.
- 110) Cai K., Yao K., Hou X., Wang Y., Hou Y., Yang Z., Li X. and Xie H., Improvement of the functions of osteoblasts seeded on modified poly(D,L-lactic acid) with poly(aspartic acid). *J. Biomed. Mater. Res.* 62: 283-291, 2002.
- 111) Chesmel K.D., Clark C.C., Brighton C.T. and Black J., Cellular responses to chemical and morphologic aspects of biomaterial surfaces. II. The biosynthetic and migratory response of bone cell populations. *J. Biomed. Mater. Res.* 29: 1101-1110, 1995.
- 112) Lincks J., Boyan B.D., Blanchard C.R., Lohmann C.H., Liu Y., Cochran D.L., Dean D.D. and Schwartz Z., Response of MG63 osteoblast-like cells to titanium and titanium alloy is dependent on surface roughness and composition. *Biomaterials*, 19: 2219-2232, 1998.
- 113) Lee S.J., Choi J.S., Park K.S., Khang G., Lee Y.M. and Lee H.B., Response of MG63 osteoblast-like cells onto polycarbonate membrane surfaces with different micropore sizes. *Biomaterials*, 25: 4699-4707, 2004.
- 114) Bignon A., Chouteau J., Chevalier J., Fantozzi G., Carret J.P., Chavassieux P., Boivin G., Melin M. and Hartmann D., Effect of micro- and macro-porosity of bone substitutes on their mechanical properties and cellular response. *J. Mater. Sci. Mater. Med.* 14: 1089-1097, 2003.
- 115) New horizons for thermoplastic polymers., Williams D., *Med. Device Technol.* 12: 8-9, 2001.
- 116) Surface activation of polyetheretherketone (PEEK) and formation of calcium phosphate coatings by precipitation; Ha S.W., Kirch M., Birchler F., Eckert K.L., Mayer J., Wintermantel E., Sittig C., Pfund-Klingenfuss I., Textor M., Spencer N.D., Guecheva M. and Vonmont H., *J. Mater. Sci. Mater. Med.* 8: 683-690, 1997.
- 117) Polyetheretherketone-cytotoxicity and mutagenicity in vitro. Katzer A., Marquardt H., Westendorf J., Wening J.V. and von Foerster G., *Biomaterials*, 23: 1749-1759, 2002.
- 118) The effects of calcium phosphate particles on the growth of osteoblasts. Sun J.S., Tsuang Y.H., Liao C.J., Liu H.C., Hang Y.S. and Lin F.H., *J. Biomed. Mater. Res.* 37: 324-334, 1997.
- 119) Un nouveau matériau en implantologie : metal-free, le Biopik, Jean-Pierre COUGOULIC, Cyril SEDARAT, Marie-Françoise HARMAND; *Implantologie Nov.* 2010.
- 120) A long-term follow-up study of osseointegrated implants in the treatment of totally edentulous jaws. Adell, R., Eriksson, B., Lekholm, U., Brånemark, P.I. & Jemt, T., *International Journal of Oral & Maxillofacial Implants.* 1990; 5: 347-359.
- 121) Zirconia abutments for single-tooth implants--rationale and clinical guidelines; u Blatz MB, Bergler M, Holst S, Block MS. *J Oral Maxillofac Surg.* 2009; 67(11 Suppl):74-81.
- 122) Osseointegrated implants in the treatment of the edentulous jaw. u Brånemark PI, Hansson BO, Adell R, Breine U, Lindström J, Hallén O, Ohman A., Experience om a 10-year period. *Scand J Plast Reconstr Surg Suppl.* 1977; 16:1-132.

- 123) In vivo bone response to biomechanical loading at the bone/dental-implant interface; Brunski JB, *Adv Dent Res.* 1999; 13:99-119.
- 124) An overview of the corrosion aspect of dental implants (titanium and its alloys); Chaturvedi TP., *Indian J Dent Res.* 2009; 20(1): 91-98.
- 125) Implant allergy register – a first report; Eben R, Walk R, Summer B, Maier S, Omsen M, Omas P. *Orthopade.* 2009; 38(6): 557-562.
- 126) Osseointegrated implants in the treatment of partially edentulous jaws: a prospective 5-year multicenter study. Lekholm, U., van Steenberghe, D., Herrmann, I., Bolender, C., Folmer, T., Gunne, J., Henry, P., Higuchi, K. & Laney, W.R., *International Journal of Oral & Maxillofacial Implants.* 1994; 9: 627-635.
- 127) Cytocompatibility of two coating materials, amorphous alumina and silicon carbide, using human differentiated cell cultures. u Najj A, Harmand MF., *Biomaterials,* 1991; 12(7): 690-694.
- 128) Polyetheretherketone--cytotoxicity and mutagenicity in vitro. u Katzer A, Marquardt H, Westendorf J, Wening JV, von Foerster G., *Biomaterials,* 2002; 23(8): 1749-1759.
- 129) Ceramic abutments and ceramic oral implants. An update. Kohal RJ, Att W, Bächle M, Butz F. ; *Periodontol 2000.* 2008; 47: 224-243.
- 130) In vitro kinetic evaluation of titanium alloy biodegradation. Sedarat C, Harmand MF, Najj A, Nowzari H, *J Periodontal Res.* 2001; 36(5): 269-274.
- 131) Surface characterization of implant materials c.p. Ti, Ti- 6Al-7Nb and Ti-6Al-4V with different pretreatments. Sittig C, Textor M, Spencer ND, Wieland M, Vallotton PH. , *J Mater Sci Mater Med.* 1999; 10(1): 35-46.
- 132) Osseointegration and clinical success of zirconia dental implants: a systematic review. Wenz HJ, Bartsch J, Wolfart S, Kern M., *Int J Prosthodont.* 2008; 21(1): 27-36.
- 133) In vitro biocompatibility of polyetheretherketone and polysulfone composites. Wenz LM, Merritt K, Brown SA, Moet A, Steffee AD, *J. Biomed. Mater. Res.* 1990; 24(2): 207-215.
- 134) Clinical Abstract Summary: Cervical and Lumbar Interbody Fusion using PEEK-OPTIMA based devices; Invibio Broschüre.
- 135) Outcomes of interbody fusion cages used in 1 and 2-levels anterior cervical discectomy and fusion: Titanium cages versus Polyetheretherketone (PEEK) cages; Niu CC, Liao JC, Chen WJ, Chen LH. *J Spinal Disord Tech.* 2010 Jul; 23(5): 310-316.
- 136) ANTERIOR CERVICAL DISCECTOMY WITH FUSION IN PATIENTS WITH CERVICAL DISC DEGENERATION: A PROSPECTIVE OUTCOME STUDY OF 258 PATIENTS (181 FUSED WITH AUTOLOGOUS BONE GRAFT AND 77 FUSED WITH A PEEK CAGE). Lied B, Roenning PA, Sundseth J, Helseth E. *BMC Surg.* 2010 Mar 21; 10: 10.
- 137) RADIOLOGICAL ANALYSIS OF 37 SEGMENTS IN CERVICAL SPINE IMPLANTED WITH A PEEK STAND-ALONE DEVICE, WITH AT LEAST ONE YEAR FOLLOW-UP. Dufour T, Huppert J, Louis C, Beaurain J, Stecken J, Aubourg L, Vila T. *Br J Neurosurg.* 2010 Jul 15. [Epub ahead of print]

138) USEFULNESS OF POLYETHERETHERKETONE (PEEK) CAGE WITH PLATE AUGMENTATION FOR ANTERIOR ARTHRODESIS IN TRAUMATIC CERVICAL SPINE INJURY. Song KJ, Choi BW, Kim GH, Song JH. *Spine J.* 2010 Jan; 10(1): 50-57. Epub 2009 Oct 9.

139) THE EFFICACY OF THE SYNTHETIC INTERBODY CAGE AND GRAFTON FOR ANTERIOR CERVICAL FUSION. Park HW, Lee JK, Moon SJ, Seo SK, Lee JH, Kim SH. *Spine (Phila Pa 1976).* 2009 Aug 1; 34(17): E591-5.

140) RADIOLOGIC ASSESSMENT OF SUBSIDENCE IN STAND-ALONE CERVICAL POLYETHERETHERKETONE (PEEK) CAGE. Ha SK, Park JY, Kim SH, Lim DJ, Kim SD, Lee SK. *J Korean Neurosurg Soc.* 2008 Dec; 44(6): 370-374.

141) TWO-LEVEL CONTIGUOUS CERVICAL DISC DISEASE TREATED WITH PEEK CAGES PACKED WITH DEMINERALIZED BONE MATRIX: RESULTS OF 3-YEAR FOLLOW-UP. Topuz K, Colak A, Kaya S, Simşek H, Kutlay M, Demircan MN, Velioglu M. *Eur Spine J.* 2009 Feb; 18(2): 238-43. Epub 2009 Jan 8.

142) ANTERIOR CERVICAL FUSION USING A POLYETHERETHERKETONE CAGE CONTAINING A BOVINE XENOGRAFT: THREE TO FIVE-YEAR FOLLOW-UP. Chiang CJ, Kuo YJ, Chiang YF, Rau G, Tsuang YH. *Spine (Phila Pa 1976).* 2008 Nov 1; 33(23): 2524-428.

143) EFFICACY OF ANTERIOR CERVICAL FUSION: COMPARISON OF TITANIUM CAGES, POLYETHERETHERKETONE (PEEK) CAGES AND AUTOGENOUS BONE GRAFTS. Chou YC, Chen DC, Hsieh WA, Chen WF, Yen PS, Harnod T, Chiou TL, Chang YL, Su CF, Lin SZ, Chen SY. *J Clin Neurosci.* 2008 Nov; 15(11):1240-5. Epub 2008 Sep 17.

144) THE SAFETY AND EFFICACY OF ANTERIOR CERVICAL DISCECTOMY AND FUSION WITH POLYETHERETHERKETONE SPACER AND RECOMBINANT HUMAN BONE MORPHOGENETIC PROTEIN-2: A REVIEW OF 200 PATIENTS. Tumialán LM, Pan J, Rodts GE, Mummaneni PV. *J Neurosurg Spine.* 2008 Jun; 8(6): 529-535.

145) POLYETHERETHERKETONE (PEEK) CAGE FILLED WITH CANCELLOUS ALLOGRAFT IN ANTERIOR CERVICAL DISCECTOMY AND FUSION. Liao JC, Niu CC, Chen WJ, Chen LH. *Int Orthop.* 2008 Oct; 32(5): 643-8. Epub 2007 Jul 17. (Comment in: *Int Orthop.* 2008 Oct; 32(5): 717.)

146) A COMPARISON OF CHANGES OVER TIME IN CERVICAL FORAMINAL HEIGHT AFTER TRICORTICAL ILIAC GRAFT OR POLYETHERETHERKETONE CAGE PLACEMENT FOLLOWING ANTERIOR DISCECTOMY. Celik SE, Kara A, Celik S. *J Neurosurg Spine.* 2007 Jan; 6(1): 10-16.

147) THE INDICATIONS FOR INTERBODY FUSION CAGES IN THE TREATMENT OF SPONDYLOLISTHESIS: ANALYSIS OF 120 CASES. McAfee PC, DeVine JG, Chaput CD, Prybis BG, Fedder IL, Cunningham BW, Farrell DJ, Hess SJ, Vigna FE. *Spine (Phila Pa 1976).* 2005 Mar 15; 30(6 Suppl): S60-5.

148) POSTERIOR LUMBAR INTERBODY FUSION USING NONRESORBABLE POLY-ETHER-ETHER-KETONE VERSUS RESORBABLE POLY-L-LACTIDE-CO-D,L-LACTIDE FUSION DEVICES: A PROSPECTIVE, RANDOMIZED STUDY TO ASSESS FUSION AND CLINICAL OUTCOME. Jiya T, Smit T, Deddens J, Mullender M. *Spine (Phila Pa 1976).* 2009 Feb 1; 34(3): 233-237.

- 149) POSTERIOR LUMBAR INTERBODY FUSION USING RHBMP-2. Meisel HJ, Schnöring M, Hohaus C, Minkus Y, Beier A, Ganey T, Mansmann U. *Eur Spine J.* 2008 Dec; 17(12): 1735-1744. Epub 2008 Oct 7.
- 150) CIRCUMFERENTIAL ARTHRODESIS USING PEEK CAGES AT THE LUMBAR SPINE. Rousseau MA, Lazennec JY, Saillant G. *J Spinal Disord Tech.* 2007 Jun; 20(4): 278-281.
- 151) A CARBON FIBER IMPLANT TO AID INTERBODY LUMBAR FUSION. TWO-YEAR CLINICAL RESULTS IN THE FIRST 26 PATIENTS. Brantigan JW, Steffee AD. *Spine (Phila Pa 1976).* 1993 Oct 15; 18(14): 2106-2107.
- 152) POSTERIOR LUMBAR INTERBODY FUSION WITH PEEK CAGES: PERSONAL EXPERIENCE WITH 20 PATIENTS. Desogus N, Ennas F, Leuze R, Maleci A. *J Neurosurg Sci.* 2005 Dec; 49(4): 137-141; discussion 141.
- 153) POLYETHERETHERKETONE AS A BIOMATERIAL FOR SPINAL APPLICATIONS. Toth JM, Wang M, Estes BT, Scifert JL, Seim HB 3rd, Turner AS. *Biomaterials,* 2006 Jan; 27(3): 324-334.
- 154) A comparative study of flexible (Polyactive®) versus rigid (hydroxylapatite) permucosal dental implants. I. Clinical Aspects G. J. MEIJER, M. S. CUNE, M. VANDOOREN, C. DEPUTTER & C. A. VAN BLITTERSWIJK, Department of Oral-Maxillofacial Surgery, Prosthodontics and Special Dental Care. Faculty of Medicine, University of Utrecht, Utrecht and Biomaterials Research Group, Faculty of Medicine, University of Leiden, Leiden, the Netherlands; Blackwell Science Ltd, *Journal of Oral Rehabilitation* 24; 85-92.
- 155) ADELL, R. (1985) Long-term treatment results. In: *Tissue-Integrated- Prosthesis: Osseointegration in Clinical Dentistry* (eds P.-I. Branemark, G.A. Zarb & T. Albrektsson), pp. 175-185. Quintessence Publishing Co., Chicago.
- 156) BARKER, D., DE WUN, J.R., VROUENRAETS, C.M.F., HESSELING, S.C., GROTE, J. J. & VAN BLITTERSWIJK, C.A. (1989) The reactions of bone to Polyactive®: a bone-bonding copolyether ester. *Polymers in Medicine and Surgery*, 6, 11.
- 157) BAKKER, D., VAN BLITTERSWIJK, C.A., HESSELING, S.C, KOERTEN, H.K., KUIPERS, W. & GROTE, J.J. (1990a), Biocompatibility of a Polyether Urethane, Polypropylene Oxide, and a Polyether Polyester Copolymer, *J. Biomed. Mater. Res.* 24, 489.
- 158) BAKKER, D., VAN BLITTERSWIJK, C.A., HESSELING, S.C, DAEMS, W.T. & GROTE, J.J. (1990b) Tissue/biomaterial interface characteristics of four elastomers. A transmission electron microscopical study. *J. Biomed. Mater. Res.* 24, 277.
- 159) BAUMAN, R., MILLS, M., RAPLEY, J.W. & HALLMON, W.H. (1992) Clinical parameters of evaluation during implant maintenance. *International Oral Maxillofacial Implants*, 7, 220.
- 160) BORCHERS, L. & REICHART, P. (1983) Three-dimensional stress distribution around a dental implant at different stages of interface development. *Journal of Dental Research*, 62, 155.
- 161) BUSER, D., WEBER, H.P. & LANG, N.P. (1990) Tissue integration of non-submerged implants, i-year results of a prospective study with 100 ITI hollow-cylinder atid hollow-screw implants. *Clinical Oral Implants Research*

- 162) CELLAND, N.L., ISMAIL, Y.H., ZAKI, H.S. & PIPKO, D. (1991) Three dimensional finite element stress analysis in and around the Screw-Vent implant. *International Journal of Oral Maxillofacial Implants*, 6, 391.
- 163) GROTE, J.J., BAKKER, D., HESSELING, C.S. & VAN BLITTERSWIJK, C.A. 1991 New alloplastic tympanic membrane material. *American Journal of Otology*, 12, 1.
- 164) D'HOEDT, B., LUKAS, D., MUHLBRADT, L. et al. (1985) The Periotest® research and clinical trials. *Deutsche Zahnärztliche Zeitschrift*, 40, 113.
- 165) KUIJ, P. VAN DER (1979) Reducing Residual Ridge Reduction. Thesis, Free University, Amsterdam.
- 166) LOE H., SILNESS J. (1963) Periodontal disease in pregnancy. I. Prevalence and severity. *Acta Odontica Scandinavia*, 21, 532.
- 167) MATSUSHITA, Y., KITO, M., MIZUTA, K., IKEDA, H. & SUETSUGU, T. (1990) Two dimensional FEM analysis of hydroxylapatite implants: diameter effects on stress distribution. *Journal of Oral Implant*, 26, 6.
- 168) MEUHR, H.J.A. (1992) A biomechanical study on bone around dental implants in an edentulous mandible. Thesis, University of Utrecht.
- 169) MEIJER, G.J., RADDER, A.M., DALMEUER, R.A., DE PUTTER, C. & VAN BLITTERSWIJK, C.A. (1995a) Observations of the bone activity adjacent to unloaded dental implants coated with Polyactive® or HA. *Journal of Oral Rehabilitation*, 22, 167.
- 170) MEIJER, G.J., STARMANS, F.J.M., DE PUTTER, C. & VAN BLITTERSWIJK, C.A. (1995b) The influence of a flexible coating on the bone stress around dental Implants. *Journal of Oral Rehabilitation*, 22, 105.
- 171) MEIJER, G.J., CUNE, M.S., VAN DOOREN, A., DE PUTTER, C. & VAN BLITTERSWIJK, C.A. (1997) A comparative study of flexible (Polyactive®) versus rigid (hydroxylapatite) perimucosal implants. II. Histological aspects. *Journal of Oral Rehabilitation*, 24, 93.
- 172) OLIVI, J. & APARICIO, C. (1990) The periotest method as measure of osseointegrated oral implant stability. *International Journal of Maxillofacial Implants*, 5, 390.
- 173) PUTTER, C. DE (1984) Perimucosal dental implants of dense hydroxylapatite; an animal experimental study. Thesis, Free University, Amsterdam.
- 174) RADDER, A.M. (1994) Bone-bonding copolymers for hard tissue replacement. Thesis, Leiden University.
- ROSSEN, I.P. VAN (1991) Dental implant loading; flexible versus rigid. Thesis, University of Amsterdam.
- 175) SCHULTE, W., LUCAS, D., MUHLBRADT, L. et al. (1983) Periotest® – ein neues Verfahren und Gerät zur Messung der Funktion des Paradontiums. *Zahnärztliche Mitteilungen*, 73, 1229.
- 176) SCHULTE, D. & LUKAS, D. (1993) Periotest® to monitor osseointegration and to check the occlusion of oral implantology. *Journal of Oral Implantology*, 1, 23.

177) SIEGELE, D. & SOLTESZ, U. (1989) Numerical investigations of the influence of implant shape on stress distribution in the jaw bone. *International Journal of Oral Maxillofacial Implants*, 4, 333.

178) SILNESS, J. & LOE, H. (1964) Periodontal disease in pregnancy II. Correlation between oral hygiene and periodontal condition. *Acta Odontologica Scandinavica*, 22, 121.

179) SHULMAN, L.B., ROGOFF, G.S., SAVITT, E.D. & KENT, R.L., Jr (1986) Evaluation in reconstructive implantology. *Dental Clinics of North America*, 30, 327.

180) SOLTESZ, U. & SIEGELE, D. (1982) Principal characteristics of the stress distributions in the jaw caused by dental implants. In: *Biomechanics: Principles and Applications* (eds R. Huisken, D. Van Campen & J.R. De Wijn), pp. 4i9-A44. Martinus Nijhof, The Hague, The Netherlands.

181) STEENBERGHE, D. VAN (1988) Periodontal aspects of osseointegrated dental implants ad modum Branemark. *Dental Clinics of Northern America*, 32, 355.

182) STEFLIK, D.E., KOTH, D.L. & MCKINNEY, R.V. (1987) Human clinical trials with the single crustal sapphire endosteal dental implant: three year results, statistical analysis and validation of an evaluation protocol. *Journal of Oral Implantology*, 8, 39.

183) TEERLINCK, J., QUIRIJNEN, M., DARIUS, P. & VAN STEENBERGHE, D. (1991) Periotest®: an objective clinical diagnosis of bone apposition toward implants. *International Journal of Oral Implants*, 6, 55.

184) VAN BLITTERSWIJK, C.A., HESSELING, S.C, VAN DEN BRINK, J., LEENDERS, H. & BARKER, D. (1991a) Reactions in polymers resulting in bone-bonding: a review of the biocompatibility of Polyactive. In: *The Bone Biomaterial Interface* (ed. J.E. Davies). Toronto.

185) VAN BLITTERSWIJK, C.A., BAKKER, D., HESSELING, S.C. & KOERTEN, H.K. (1991b) Reactions of cells at implant surfaces. *Biomaterials*, 12, 187.

186) VAN BLITTERSWIJK, C.A., BAKKER, D., LEENDERS, H. et al. (1992) Interfacial reactions leading to bone-bonding with PEO/PBT copolymers (Polyactive®). In: *Bone-bonding Biomaterials* (eds P. Ducheyne, T. Kokubo & C.A. van Blitterswijk), pp. 13-30. Reed Healthcare Communciations, Leiderdorp.

- 187) VAN BLITTERSWIJK, C.A., VAN DEN BRINK, J., LEENDERS, H. & BAKKER, D. (1993) The effect of PEO ratio on degradation, calcification and bone-bonding of PEO/PBT copolymer (Polyactive®). *Cells and Materials*, 3, 23.
- 188) VAN DER VELDE, U. (1986) The influence of probing force on the reproducibility of bleeding tendency measurements. *Journal of Clinical Periodontology*, 7, 75.
- 189) Use of Customized Polyetheretherketone (PEEK) Implants in the Reconstruction of Complex Maxillofacial Defects Michael M. Kim, MD; Kofi D. O. Boahene, MD; Patrick J. Byrne, MD; (REPRINTED) *ARCH FACIAL PLAST SURG/VOL 11 (NO. 1), JAN/FEB 2009*
- 190) Tessier P. Autogenous bone grafts taken from the calvarium for facial and cranial applications. *Clin Plast Surg*. 1982; 9(4): 531-538.
- 191) Maas CS, Merwin GE, Wilson J, Frey MD, Maves MD. Comparison of biomaterials for facial bone augmentation. *Arch Otolaryngol Head Neck Surg*. 1990; 116(5):551-556.
- 192) Jockisch KA, Brown SA, Bauer TW, Merritt K. Biological response to chopped carbon-fiber-reinforced PEEK. *J. Biomed. Mater. Res*. 1992; 26(2): 133-146.
- 193) Morrison C, Macnair R, MacDonald C, Wykman A, Goldie I, Grant MH. In vitro biocompatibility testing of polymers for orthopaedic implants using cultured fibroblasts and osteoblasts. *Biomaterials*, 1995; 16(13): 987-992.
- 194) Wenz LM, Merritt K, Brown SA, Moet A, Steffee AD. In vitro biocompatibility of polyetheretherketone and polysulfone composites. *J. Biomed. Mater. Res*. 1990; 24(2): 207-215.
- 195) Toth JM, Wang M, Estes BT, Scifert JL, Seim HB III, Turner AS. Polyetheretherketone as a biomaterial for spinal applications. *Biomaterials*, 2006; 27(3): 324-334.
- 196) Cho DY, Liao WR, Lee WY, Liu JT, Chiu CL, Sheu PC. Preliminary experience using a polyetheretherketone (PEEK) cage in the treatment of cervical disc disease [published correction appears in *Neurosurgery*. 2003; 52(3): 693]. *Neurosurgery*. 2002; 51(6): 1343-1350.
- 197) Spruit M, Falk RG, Beckmann L, Steffen T, Castelein RM. The in vitro stabilising effect of polyetheretherketone cages versus a titanium cage of similar design for anterior lumbar interbody fusion. *Eur Spine J*. 2005; 14(8): 752-758.
- 198) Sekerci Z, Uğur A, Ergün R, Sanli M. Early changes in the cervical foraminal area after anterior interbody fusion with polyetheretherketone (PEEK) cage containing synthetic bone particulate: a prospective study of 20 cases. *Neurol Res*. 2006; 28(5): 568-571.
- 199) Mastronardi L, Ducati A, Ferrante L. Anterior cervical fusion with polyetheretherketone (PEEK) cages in the treatment of degenerative disc disease: preliminary observations in 36 consecutive cases with a minimum 12-month follow-up. *Acta Neurochir (Wien)*. 2006; 148(3): 307-312.
- 200) Scolozzi P, Martinez A, Jaques B. Complex orbito-fronto-temporal reconstruction using computer-designed PEEK implant. *J Craniofac Surg*. 2007; 18(1): 224-228.
- 201) PSI-Patient Specific Implants. West Chester, PA: Synthes Inc; 2004.



- 202) The long-term mechanical integrity of non-reinforced PEEK-OPTIMA polymer for demanding spinal applications: experimental and finite-element analysis; Stephen J. Ferguson Judith M. A. Visser, Anne Polikeit, *Eur Spine J* (2006) 15: 149-156. DOI 10.1007/s00586-005-0915-5
- 203) Abu Bakar MS, Cheng MH, Tang SM, Yu SC, Liao K, Tan CT, Khor KA, Cheang P (2003) Tensile properties, tension-tension fatigue and biological response of polyetheretherketonehydroxyapatite composites for loadbearing orthopedic implants. *Biomaterials*, 24: 2245–2250.
- 204) Akay M, Aslan N (1995) An estimation of fatigue life for a carbon fibre/poly ether ether ketone hip joint prosthesis. *Proc Inst Mech Eng [H]* 209: 93-103.
- 205) Akay M, Aslan N (1996) Numerical and experimental stress analysis of a polymeric composite hip joint prosthesis. *J. Biomed. Mater. Res.* 31: 167-182.
- 206) Albert K, Schledjewski R, Harbaugh M, Bleser S, Jamison R, Friedrich K (1994) Characterization of wear in composite material orthopaedic implants. Part II: The implant/bone interface. *Biomed Mater Eng* 4: 199-211.
- 207) ASTM D2990–01 (2004) Standard test methods for tensile, compressive, and flexural creep and creep-rupture of plastics
- 208) ASTM D695–02 (2004) Standard test method for compressive properties of rigid plastics
- 209) Baidya KP, Ramakrishna S, Rahman M, Ritchie A (2001) Quantitative radiographic analysis of fiber reinforced polymer composites. *J Biomater Appl* 15:279–289
- 210) Brown SA, Hastings RS, Mason JJ, Moet A (1990) Characterization of short-fibre reinforced thermoplastics for fracture fixation devices. *Biomaterials*, 11:541–547
- 211) Chabrier F, Lloyd CH, Scrimgeour SN (1999) Measurement at low strain rates of the elastic properties of dental polymeric materials. *Dent Mater* 15:33–38
- 212) Cho DY, Liao WR, Lee WY, Liu JT, Chiu CL, Sheu PC (2002) Preliminary experience using a polyetheretherketone (PEEK) cage in the treatment of cervical disc disease. *Neurosurgery* 51:1343– 1349
- 213) Cook SD, Rust-Dawicki AM (1995) Preliminary evaluation of titaniumcoated PEEK dental implants. *J Oral Implantol* 21:176–181

- 214) Cripton PA (1993) Compressive characterization of ultra high molecular weight polyethylene with applications to contact stress analysis of total knee replacements. MSc Thesis, Queen's University
- 215) 13. Diedrich O, Kraft CN, Perlick L, Schmitt O (2001) The posterior lumbar interbody fusion with cages (PLIF) and transpedicular stabilization. *Zentralbl Neurochir* 62:106–113
- 216) Frei H, Oxland TR, Rathonyi GC, Nolte LP (2001) The effect of nucleotomy on lumbar spine mechanics in compression and shear loading. *Spine* 26:2080–2089
- 217) Grant JP, Oxland TR, Dvorak MF (2001) Mapping the structural properties of the lumbosacral vertebral endplates. *Spine* 26:889–896
- 218) Hunter A, Archer CW, Walker PS, Blunn GW (1995) Attachment and proliferation of osteoblasts and fibroblasts on biomaterials for orthopaedic use. *Biomaterials*, 16:287–295  
17. Jockisch KA, Brown SA, Bauer TW, Merritt K (1992) Biological response to chopped-carbon-fiber-reinforced peek. *J. Biomed. Mater. Res.* 26: 133-146.
- 219) Katozian H, Davy DT, Arshi A, Saadati U (2001) Material optimization of femoral component of total hip prosthesis using fiber reinforced polymeric composites. *Med Eng Phys* 23: 503-509
- 220) Response of primary fibroblasts and osteoblasts to plasma treated polyetheretherketone (PEEK) surfaces; D. BRIEM<sup>1</sup>, S. STRAMETZ<sup>1</sup>, K. SCHRÖDER<sup>2</sup>, N. M. MEENEN<sup>1</sup>, W. LEHMANN<sup>1</sup>, W. LINHART<sup>1</sup>, A. OHL<sup>2</sup>, J. M. RUEGER<sup>1</sup> <sup>1</sup>Department of Trauma-, Hand- and Reconstructive Surgery, Hamburg University, School of Medicine, Martinistr. 52, D-20246 Hamburg, Germany; E-mail: briem@uke.uni-hamburg.de  
<sup>2</sup>Institut für Niedertemperatur-Plasmaphysik (INP), Friedrich-Ludwig-Jahnstr. 19, D-17489 Greifswald, Germany  
*JOURNAL OF MATERIALS SCIENCE: MATERIALS IN MEDICINE* 16 (2005) 671-677; Received 16 September 2003 and accepted 20 July 2004.
- 221) T. A. HORBETT, in “Proteins at Interfaces,” edited by T. A. Horbett and T. A. Brash (American Chemical Society, Washington DC, 1987).
- 222) B. D. RATNER, in “Comprehensive Polymer Science,” edited by G. Allen and J. C. Bevington (Pergamon Press, New York, 1989), 201.
- 223) R. THULL, *Orthopade* 32 (2003) 51. 4. B. D. RATNER, in “Surface Modification of Polymeric Biomaterials, edited by B. D. Ratner and D. G. Castner (Plenum Press, New York, 1997), 35.
- 224) A. BRUNHOLD, F. KLEINERT, R. SCHNABEL and S. MARINOW, *Lackiertechnik* 51 (1997) 37.
- 225) D. KLEE and H. HÖCKER, *Spektrum der Wissenschaft* 6 (1995) 90.
- 226) R. D'AGOSTINO, Academic Press, 1990.
- 227) D. M. MANOS and D. L. FLAMM, Academic Press, 1986.
- 228) C. MORRISON, R. MACNAIR, C. MACDONALD, A. WYKMAN, I. GOLDIE and M. H. GRANT, *Biomaterials*, 16 (1995) 987.

- 229) D. F. WILLIAMS and A. McNAMARA, *J. Mater. Sci. Lett.* 6 (1987) 188.
- 230) J. A. BRYDSON (ed.) "Aromatic Polyetherketones" Butterworths London, 1989.
- 231) C. P. SMITH, *Swiss Plastics* 3 (1981) 37.
- 232) M. DAUNER, H. PLANCK and H. J. BRÜNING, *Hefte zur Zeitschrift „Der Unfallchirurg“* 234 (1994) 25.
- 233) O. NOISET, Y. J. SCHNEIDER and J. MARCHAND-BRYNAERT, *J. Biomater. Sci. Polym. Ed* 10 (1999) 657.
- 234) Idem, *ibid.* 11 (2000) 767.
- 235) S. D. COOK and A. M. RUST-DAWICKI, *J. Oral. Implantol.* 21 (1995) 176.
- 236) K. SCHRÖDER, A. MEYER-PLATH, D. KELLER, W. BESCH, G. BABUCKE and A. OHL, *Contrib. Plasma. Phys.* 41 (2001) 562.
- 237) K. SCHRÖDER, D. KELLER, A. MEYER-PLATH, U. MÜLLER and A. OHL, in "Materials for Medical Engineering", edited by H. Stallforth and P. Revell (Weinheim, Wiley-VCH, 2000) 161.
- 238) K. SCHRÖDER, A. MEYER-PLATH, D. KELLER and A. OHL, *Plasm. Polym.* 7 (2002) 103.
- 239) P. DUCY, M. STARBUCK, M. PRIEMEL, J. SHEN, G. PINERO, V. GEOFFROY, M. AMLING and G. KARSENTY, *Genes Dev.* 13 (1999) 1025.
- 240) G. ZHANG, R. A. LATOUR, JR., J. M. KENNEDY, S. H. DEL, JR. and R. J. FRIEDMAN, *Biomaterials*, 17 (1996) 781.
- 241) L. M. WENZ, K. MERRITT, S. A. BROWN, A. MOET and A. D. STEFFEE, *J. Biomed. Mater. Res.* 24 (1990) 207.
- 242) A. HUNTER, C. W. ARCHER, P. S. WALKER and G. W. BLUNN, *Biomaterials*, 16 (1995) 287.
- 243) A. KATZER, H. MARQUARDT, J. WESTENDORF, J. V. WENING and G. VON FOERSTER, *ibid.* 23 (2002) 1749.

- 244) K. C. OLBRICH, T. T. ANDERSEN, F. A. BLUMENSTOCK and R. BIZIOS, *ibid.* 17 (1996) 759.
- 245) D. A. PULEO, L. A. HOLLERAN, R. H. DOREMUS and R. BIZIOS, *J. Biomed. Mater. Res.* 25 (1991) 711.
- 246) A. REZANIA, C. H. THOMAS and K. E. HEALY, *Ann. Biomed. Eng.* 25 (1997) 190.
- 247) D. J. SIMMONS, G. N. KENT, R. L. JILKA, D. M. SCOTT, M. FALLON and D. V. COHN, *Calcif. Tissue Int.* 34 (1982) 291.
- 248) C. HENDRICH, U. NOTH, U. STAHL, F. MERKLEIN, C. P. RADER, N. SCHUTZE, R. THULL, R. S. TUAN and J. EULERT, *Clin. Orthop.* (2002) 278.
- 249) W. LINHART, F. PETERS, W. LEHMANN, K. SCHWARZ, A. F. SCHILLING, M. AMLING, J. M. RUEGER and M. EPPLE, *J. Biomed. Mater. Res.* 54 (2001) 162.
- 250) J. O. HOLLINGER and J. P. SCHMITZ, *Ann. N. Y. Acad. Sci.* 831 (1997) 427.
- 251) J. MEYER, B. WIES, M. KANTLEHNER and H. KESSLER, in "Zelluläre Interaktion mit Biomaterialien," edited by N. M. Meenen, A. Katzer and J. M. Rueger Berlin (Heidelberg, Springer Verlag, 2000) p. 33.
- 252) A. OHL and K. SCHRÖDER, *Surf. Coat. Tech.* 116–119 (1999) 820.
- 253) A Polyaryletherketone Biomaterial for use in Medical Implant Applications Dr. Stuart Green  
Vitrex plc, Vitrex Technology Centre, Hillhouse International, Thornton Cleveleys, Lancashire,  
FY5 4QD Jörg Schlegel  
Vitrex Europa GmbH, Zanggasse 6, D-65719 Hofheim Germany; information on PEEK-  
OPTIMA™
- 254) Vitrex PEEK-OPTIMA™ Product Guide.
- 255) Andres T.E. and Griffiths I., *Proceedings of 1998 SPE Annual West Regional Meeting*,  
Anaheim, CA (Soc. Pet. Eng. Richardson, TX, USA, 1998) PP 203-7
- 256) Brantigan J.W. et al., *Spine* 19, No.13 pp 1436-1444
- 257) Semadeni M., *Process Development and Materials Optimisation of Injection Moulded Anisotropic (CF/PEEK) Hip Joint Endoprosthesis Stems*. PhD Thesis, ETH No 13177, submitted to the Swiss Federal Institute of Technology, Zurich. 1999.
- 258) Yildiz H., Chang F., and Goodman S., *J. Biomed. Mater. Res.* 39, 102-119, 1998.
- 259) Thomas P., et. al., *SAMPE EUROPE/JEC, Conference 1999, Paris, 13-15 April.*

- 260) Tognini R., et. al., Twelfth International Conference on Composite Materials (ICCM-12). 1999, Paris, France.
- 261) Polineni V.K., et. al., Alternative Bearing Surfaces in Total Joint Replacement, ASTM STP 1346, J.J.Jacobs and T.L. Craig, Eds., American Society for Testing and Materials, 1998.
- 262) Esbach L Nonresorbable polymers in bone surgery, *Injury, Int.J. Care Injured* 31 (2000) S-D22-27.
- 263) Meenan B.J., McClorey C. and Akay M., *Journal of Materials Science: Materials in Medicine* 11 (2000) PP 481-489.
- 264) Lin T.W. et. al., Society for Biomaterials 23rd Annual Meeting, New Orleans, LA, April 30-May 4, 1997.
- 265) Williams D.F., McNamara A. and Turner R.M., *J.Mater. Sci. Lett.* 6 (1987) 188.
- 266) Jockisch K.A., Brown S.A., Bauer T.W. and Merritt K, *J. Biomed. Mater. Res.* 26 (1992) 133-146.
- 267) Morrison C., McNair R., McDonald C., Wykman A., Goldie I. and Grant M.H., *Biomaterials*, 16 (1995) 987.
- 268) Sevostianov I.B., *Composite Structures* 43 (1998) 109.
- 269) Kwerteng K.B. and Stark C., *SAMPE Quarterly*, October 1990.
- 270) Taking a PEEK at Material Options for Orthopedics; Amy Kinbrum, PhD, January 2009. [www.mdtmag.com](http://www.mdtmag.com)
- 271) Joyce TJ, et al. A multi-directional wear screening device and preliminary results of UHMWPE articulating against stainless steel. *Biomedical Materials and Engineering.* 10 (3-4); 2000: 241-249.
- 272) Scholes SC and Unsworth A. The wear properties of CFR-PEEK-OPTIMA articulating against ceramic assessed on a multidirectional pin-on-plate machine. *Proc. I Mech E Part H: J. Engineering in Medicine.* Vol. 221; 2006: 281-289.
- 273) Berger T. *Biospine 2 Congress.* Leipzig: Sept. 2007.
- 274) Pace N, et al. Clinical Trial of a New CF-PEEK Acetabular Insert in Hip Arthroscopy. Abstracts from the European Hip Society: 2002 Domestic Meeting.
- 275) Manley M, et al. Biomechanics of a PEEK horseshoe-shaped cup: Comparisons with a predicate deformable cup. Paper C655/058. Institution of Mechanical Engineers, "Engineers & Surgeons: Joined at the Hip" London, April 19?21, 2007.
- 276) Smith S and Unsworth A. A comparison between gravimetric and volumetric techniques of wear measurement of UHMWPE acetabular cups against zirconia and cobalt–chromium–molybdenum femoral heads in a hip simulator. Part H Technical Note; *Proc Instn Mech Engrs* Vol. 213; 1999: 475–484.

277) Scholes SC, Unsworth A, and Jones E. Long term wear behaviour of a flexible, anatomically loaded hip cup design. International Society for Technology in Arthroplasty.

278) Howling, et al. Biological response to wear debris generated in carbon based composites as potential bearing surfaces for artificial hip joints. J. Biomed. Mater. Res. Part B Appl Biomater. 67B; 2003: 758-764.

279) Latif AMH, et al. Pre-clinical studies to validate the MITCH PCR Cup: a flexible and anatomically shaped acetabular component with novel bearing characteristics; J Mater Sci. Mater Med: Online. press releases: Maastricht University Medical Centre Advances Cranial Implant Technology with PEEK-OPTIMA; 2010-06-01.

280) L'APRES TITANE, LE PEEK ? After titanium, peek ?; Jean Paul Meningaud, MD, PhD; Jean-Marie Donsimoni; Laurent Lantieri, Université Paris 12, Faculté de Médecine, IFR10, Créteil, F-94000, France AP-HP, Groupe Henri Mondor-Albert Chenevier, Service de chirurgie plastique, reconstructrice et esthétique, Créteil, F-94000, France; Elsevier Editorial System(tm) for Revue de Stomatologie et de Chirurgie Maxillo-faciale, Manuscript Draft.

281) Fujihara K, Huang ZM, Ramakrishna S, Satknanantham K, Hamada H. Performance study of braided carbon/PEEK composite compression bone plates. Biomaterials, 2003, 24: 2661-2667.

282) Abu Bakar MS, Cheng MH, Tang SM et al. Tensile properties, tension-tension fatigue and biological response of polyetheretherketon-hydroxyapatite composites for load-bearing orthopaedic implants. Biomaterials, 2003; 24: 2245- 2250.

283) FR 2600523 A Camprasse Serge, Camprasse George 31.12.1987 p.1-3, ligne 35.

284) US 6 193 516 B1 Story Brooks J, rang. 3, ligne 36.

285) US 5006 984 A Steele, Charles R, rang. 3, lignes 44-50.

286) Katzer A, Marquardt H, Westendorf J, Wening JV, von Foerster G. Polyetheretherketone-Cytotoxicity and Mutagenicity in vitro. Biomaterials, 2002; 23: 1749-1759.

287) Cook SD, Rust-Dawicki AM. Preliminary evaluation of titanium-coated PEEK dental implants. J Oral Implantol 1995; 21: 176-181.

288) Tetelman ED, Babbush CA. A new transitional abutment for immediate aesthetics and function. Implant Dent 2008; 17: 51-58.

- 289) Cho DY, Liau WR, Lee WY, Liu JT, Chiu CL, Sheu PC. Preliminary experience using a polyetheretherketone (PEEK) cage in the treatment of cervical disc disease. *Neurosurgery* 2002; 51:1343-1349.
- 290) Katoozian H, Davy DT, Arshi A, Saadati U. Material optimization of femoral component of total hip prosthesis using fiber reinforced polymeric composites. *Med Eng Phys* 2001; 23: 503-509.
- 291) Briem D, Strametz S, Schröder K et al. Response of primary fibroblasts and osteoblasts to plasma treated polyetheretherketone (PEEK) surfaces. *J Mat Science Mater Med* 2005; 16: 671-677.
- 292) Citak M, Kendoff D, Wanich T et al. The influence of metal artifacts on navigation and the reduction of artifacts by the use of polyether-ether-ketone. *Comput Aided Surg* 2008; 13: 233-239.
- 293) Ferguson SJ, Visser MA, Polikeit A. The long-term mechanical integrity of nonreinforced PEEK-OPTIMA polymer for demanding spinal applications: experimental and finite-element analysis. *Eur Spine J* 2006; 15: 149-156.
- 294) Hao L, Harris R. Customised Implants for Bone Replacement and Growth, in P. Bartolo, B. Bidanda (eds.), *Bio-Materials and Prototyping Applications in Medicine*, Springer 2008.
- 295) Scolozzi P, Martinez A, Jaques B. Complex orbito-fronto-temporal reconstruction using computer-designed PEEK implant. *J Craniofac Surg.* 2007; 18:224-228.
- 296) Hanasono M, Goel N, DeMonte F. Calvarial Reconstruction With Polyetheretherketone Implants. *Ann Plastic Surg* 2009; 62: 653-655.
- 297) Chabrier F, Lloyd CH, Scrimgeour SN. Measurements at low strain rates of the elastic properties of dental polymeric materials. *Dent Mater* 1999; 15: 33-38.
- 298) Meijer GJ, Starmans FJM, De Putter C, Van Bliiterswijk CA. The influence of a flexible coating on the bone stress around dental implants. *Journal of Oral Rehabilitation* 1995; 22: 105-111.
- 299) Cougoulic JP. LE BIOPIK (Mise sur le marché d'un implant axial en PEEK) Communication personnelle, Pornichet, Dec. 2009.
- 300) Petrovic L, Pohle D, Münstedt H, Rechtenwald T, Schlegel KA, Rupprecht S. Effect of beta-TCP filled polyetheretherketone on osteoblast cell proliferation in vitro, *J Biomed Science* 2006; 13: 41-46.
- 301) Donsimoni JM. DE102007018899A1, 19/04/2007.
- 302) Dédienne-Santé SA, mas des Cavaliers, 217, rue Nungesser, F-34130 Mauguio, France
- 303) Module Eléments Finis du logiciel CATIA V5 R7, développé par Dassault Systèmes.

304) Caractérisation mécanique d'implants maxillo-faciaux – rapport d'essai, Dossier J030087, Laboratoire Nationale de Métrologie et d'Essais, F-78197 Trappes Cedex.

305) Meningaud JP, Donsimoni JM, Lantieri L. Allogreffe de face et implantologie basale. Rev Stomatol Chir Maxillofac 2009; 110: 353-358.