

Course title: Fiber-reinforced polymer materials in dental prosthetics

Department: Department of fixed prosthodontics

Address: Gundulićeva 5; classes at Clinical hospital "Dubrava" - A. G. Šuška 6

Total ECTS points: 3

Course leader: Prof.dr.sc. Denis Vojvodić

Course associates:

Teaching plan

	No. classes
Lecture	5
Seminar	5
Practical	5
Total	15

1 class = 45 minutes

Course description:

deals with the issue of strengthening polymer materials which are today widely used in dentistry, especially prosthodontics. Glass, polyethylene, carbon and aramid fibers are used for reinforcement and good bond between the reinforcement fibers and the polymer base of the matrix is of particular importance in order to prevent delamination. The course also deals with the basics of fracture mechanics and the role of fibers in its prevention. The incorporation of fibers creates anisotropic materials with new improved properties, but the properties of these materials are greatly influenced by the direction of fiber laying as well as the depth of fiber laying within the polymer base. In their practical work, students make samples of fiber-reinforced polymers whose strength is tested by various tests. They differ in the shape and dimensions of the samples and in the way of loading (bending, tensile, pressure, shear tests) with which students should be acquainted in detail in order to properly select and use them in their future scientific work. Microscopic examination of the tested samples is important for the assessment of the connection between the fibers and the polymer base, because in this way the success of the reinforcement is assessed. For the microscopy of samples, it is important to prepare samples, which consists of pouring the samples into the resin, cutting the samples to obtain the required and desired cross-section, and polishing the samples to a smooth surface suitable for microscopy. This practical work of students would certainly be useful in the preparation of samples for future similar research in this area.

Learning outcomes

1. list and describe the possibilities of application of fiber-reinforced composites (FRC) in dental medicine, and especially dental prosthetics,
2. understand and apply reinforcements using different fibers, be able to explain the fracture mechanics and the importance of good connection of fibers and polymer base (matrix) on the success of reinforcement,

3. evaluate FRC with regard to the test of the achieved value of strength, fracture character, the quality of the connection between the reinforcement fibers and the matrix, the impact of (artificial) aging of the material,
4. create new FRC by combining the type, direction and depth of laying and impregnation of reinforcement fibers with different types of polymer biocompatible material.

Course content

Lecture

	Lecture topics	Number of classes/hours
1.	Fiber Reinforced Composites (FRC) - requirements they meet	1
2.	Construction of FRC - fibers used, their impregnation, adhesion of the fiber surface with the matrix	1
3.	Mechanical properties of FRC and loads they can withstand	1
4.	Fracture mechanics	1
5.	Aging (artificial) of FRC materials and impact on mechanical properties	1

Seminari

	Seminar topics	Number of classes/hours
1.	Clinical concepts of FRC material usage	1
2.	Structural features of fiber-reinforced fixed prosthodontic works	1
3.	Structural features of fiber reinforced removable prosthodontic works	1
4.	Features of commercial and/or individually made posts and cores	1
5.	Conclusions, remarks and future trends in the use of FRC materials	1

1 sat = 45 minuta

Vježbe

	practicals topics	Number of classes/hours
1.	Impregnation of reinforcement fibers (glass)	-
2.	Production of FRC samples for testing	-
3.	Sample strength testing (universal testing machine)	-
4.	Preparation of samples for microscopy (pouring into resin, cutting, polishing)	-
5.	Microscoping of the samples	-

1 class = 45 minutes

Literature:

Scribante A, Vallittu PK, Özcan M, Lassila LVJ, Gandini P, Sfondrini MF. Travel beyond Clinical Uses of Fiber Reinforced Composites (FRCs) in Dentistry: A Review of Past Employments, Present Applications, and Future Perspectives. *Biomed Res Int.* 2018 Oct 22;2018:1-8. doi:10.1155/2018/1498901.

Vallittu PK. High-aspect ratio fillers: fiber-reinforced composites and their anisotropic properties. *Dent Mater.* 2015;31(1):1-7. doi: 10.1016/j.dental.2014.07.009.

Vallittu PK. An overview of development and status of fiber-reinforced composites as dental and medical biomaterials. *Acta Biomater Odontol Scand.* 2018;4(1):44-55. doi: 10.1080/23337931.2018.1457445.

Garoushi S, Gargoum A, Vallittu PK, Lassila L. Short fiber-reinforced composite restorations: A review of the current literature. *J Investig Clin Dent.* 2018;9(3):p. e12330. doi: 10.1111/jicd.12330.

Suzaki N, Yamaguchi S, Nambu E, Tanaka R, Imazato S, Hayashi M. Fabricated CAD/CAM Post-Core Using Glass Fiber-Reinforced Resin Shows Innovative Potential in Restoring Pulpless Teeth. *Materials (Basel).* 2021 Oct 19;14(20):6199. doi: 10.3390/ma14206199.

Suzaki N, Yamaguchi S, Hirose N, Tanaka R, Takahashi Y, Imazato S, Hayashi M. Evaluation of physical properties of fiber-reinforced composite resin. *Dent Mater.* 2020;36(8):987-996. doi: 10.1016/j.dental.2020.04.012.

Vallittu PK, Shinya A, Baraba A, Kerr I, Keulemans F, Kreulen C, Lassila L, Malmstrom H, Novotny R, Peumans M, Van Rensburg J, Wolff D, Özcan M. Fiber-reinforced composites in fixed prosthodontics – Quo vadis? *Dent Mater.* 2017;33(8):877-879. doi: 10.1016/j.dental.2017.05.001.

Patnana AK, Vanga NRV, Vabbalareddy R, Chandrabhatla SK. Evaluating the fracture resistance of fiber reinforced composite restorations - An in vitro analysis. *Indian J Dent Res.* 2020;31(1):138-144. doi: 10.4103/ijdr.IJDR_465_18.

Perea-Lowery L, Vallittu PK. Framework design and pontics of fiber-reinforced composite fixed dental prostheses - An overview. *J Prosthodont Res.* 2018;62(3):281-286. doi: 10.1016/j.jpor.2018.03.005.

Tiu J, Belli R, Lohbauer U. Thickness influence of veneering composites on fiber-reinforced systems. *Dent Mater.* 2021 Mar;37(3):477-485. doi: 10.1016/j.dental.2020.12.002.

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Lassila L, Keulemans F, Säilynoja E, Vallittu PK, Garoushi S. Mechanical properties and fracture behavior of flowable fiber reinforced composite restorations. *Dent Mater.* 2018;34(4):598-606. doi: 10.1016/j.dental.2018.01.002.

Lassila L, Garoushi S, Vallittu PK, Säilynoja E.J. Mechanical properties of fiber reinforced restorative composite with two distinguished fiber length distribution. *Mech Behav Biomed Mater.* 2016;60:331-338. doi: 10.1016/j.jmbbm.2016.01.036. –

Frese C, Decker C, Rebholz J, Stucke K, Staehle HJ, Wolff D. Original and repair bond strength of fiber-reinforced composites in vitro. *Dent Mater.* 2014;30(4):456–462. doi: 10.1016/j.dental.2014.01.010.

Rajak DK, Pagar DD, Menezes PM, Linul E. Fiber-Reinforced Polymer Composites: Manufacturing, Properties, and Applications—Review. *Polymers.* 2019;11:1667. doi: 10.3390/polym11101667.

Powers JM, Wataha JC. Dental Materials: Foundation and Applications. 11th ed. St. Louis; Elsevier; 2016.

Vallittu P, Mutlu Özcan. Clinical Guide to Principles of Fiber-Reinforced Composites in Dentistry. Duxford; Elsevier/Woodhead Publishing; 2017.

CV (*curriculum vitae*) and bibliography of course leader

Prof.prim.dr.sc. Denis Vojvodić

- born in 1963 in Zagreb.

In 1982 he graduated from the dental school in Zagreb, and in 1989. graduated from the Faculty of Dentistry, University of Zagreb and began working at the Department of Fixed Prosthodontics at the School of Dental Medicine in Zagreb as a junior research assistant.

1992 he defended his master's thesis in 1995 passed the specialist exam in dental prosthodontics, and in 1996 defended his dissertation.

1997 Assistant Professor at the School of Dental Medicine, University of Zagreb, since 2002, Associate Professor, 2006 full professor, 2011 full professor in a permanent position.

Study stays in Wehrheim (Germany), Nijmegen (Netherlands), Zuerich (Switzerland) where he studied in the fields of dental materials, implantology and "defect prosthodontics".

In his professional, clinical work, he shows special interest in solving the problem of prosthetic care of patients with orofacial defects, prosthetic superstructures on implants, and the use of glass fibers in dental prosthetics,

Participates in undergraduate and postgraduate classes at the School of Dental Medicine and School of Medicine, University of Zagreb.

He was the principal investigator and leader of two projects approved and funded by the Ministry of Science, Education and Sports (2007-2014).

He actively participated in several domestic and international scientific and professional conferences, some as an invited lecturer, and held several lectures and courses under the auspices of the School of Dental Medicine, the Croatian Dental Society and the Croatian Dental Chamber.

Bibliography at: <https://www.bib.irb.hr/pregled/profil/29362>