

Course title **Experimental photopolymerization**

Department Department of Endodontics and Restorative Dentistry

Address Gunduliceva 5, 10000 Zagreb

Total ECTS points

Course director: Alena Knezevic Cizmic, DMD, MS, PhD, Associate Professor, Herman Ostrow School of Dentistry of USC, Department of Restorative Science, University of Southern California, Los Angeles

Faculty: Zrinka Tarle DMD, MS, PhD, Eva Klaric DMD, MS, PhD, Nevenka Kopjar MS, PhD

Teaching plan

	No. classes
Lecture	6
Seminar	5
Practice	2
Total	13

1 class = 45 minutes

Course description

Light cure dental materials and curing lights for their photopolymerization are the common subject of ongoing research and development. The purpose of the course is to familiarize candidates with the fundamental chemical and physical principles of photopolymerization of light cured dental materials, photoinitiators present in light-curing dental materials, light curing units for photopolymerization, the characteristics of individual light curing units and polymerization modes, their indications and contraindications in clinical use, the impact of the light curing intensity on the degree of conversion, polymerization shrinkage, polymerization stress, temperature increase, cytotoxicity and genotoxicity. Lectures and discussion at seminars will be also focused on "single peak" and "dual-peak" LED light curing units and how to apply these units to various photoinitiators present in light curing dental materials. Candidates will learn how to determine and achieve maximum efficiency of curing light applied to the composite material (MARC Resin Calibrator, MARC patient simulator), the optical characteristics of the light guide tip ("beam profile", "R value") and how to optimize the existing light curing unit in order to achieve maximum efficiency. Influence of photopolymerization with light curing units on different composition of composite materials will be also discussed, as well as how to implement infection control measures and measures to protect the eyes of the operator and assistant.

Learning outcomes

After completing this course, students will be able to:

1. Know how to select the most appropriate light curing unit for photopolymerization with respect to the degree of conversion, polymerization shrinkage, temperature, cytotoxicity and genotoxicity, polymerization stress and light curing materials that are used in clinical practice

2. Know how to determine the characteristics of the light curing unit necessary for sufficient photopolymerization
3. Know the difference between "single peak" and "dual-peak" LED light curing units, how to use them in different clinical situations
4. Know the basic principles of "beam profile" of the light curing unit, its effect on the photopolymerization and how to deal in the situation when the "beam profile" is not known
5. Being able to carry out simple clinical procedures for determining the quality of polymerization
6. Know how to compensate the negative effects of temperature increase, polymerization contraction and polymerization stress
7. Know how to properly maintain light curing unit, how to implement infection control measures and measures to protect the eyes of the operator.

Course content

Participants will have the opportunities to learn about basic principles of photopolymerization, photoinitiators, light curing units for photopolymerization of light curing materials, degree of conversion of composite materials, polymerization shrinkage and polymerization shrinkage stress, temperature increase during light curing and cytotoxicity caused by photopolymerization of composite materials. Participants will have opportunity to learn about maintenance of light curing unit, how to proceed with infection control measurements and how to prevent optical hazard of blue/violet light emitted from the light curing unit. All lectures and seminars will be held online. During the seminars participants will actively participate in analysis and discussion of research articles related to photopolymerization which are currently available on PubMed.

Lecture

	Lectures	Number of classes/hours
1.	- Basic principles of photopolymerization. - Photoinitiators.	1
2.	- Curing lights for photopolymerization.	2
3.	- Degree of conversion of composite materials, polymerization shrinkage and polymerization shrinkage stress	1
4.	- Temperature increase during composite materials photopolymerization. - Cytotoxicity caused by photopolymerization.	1
5.	- Light curing unit maintenance, infection control and optical hazard.	1
6.	-	
7.	-	
8.	-	
9.	-	-
10.	-	-

1 sat = 45 minuta

Seminars

	Seminars	Number of classes/hours
1.	- Photoinitiators and curing lights for photopolymerization (literature review)	-
2.	- Degree of conversion of composite materials, polymerization shrinkage and polymerization shrinkage stress, temperature increase and cytotoxicity (literature review)	2
3.	-	3
4.	-	-
5.	-	-
6.	-	-
7.	-	-
8.	-	-
9.	-	-
10.	-	-

1 sat = 45 minuta

Practice

	Practice	Number of classes/hours
1.	- Degree of conversion measurement	1
2.	- Cytotoxicity caused by photopolymerization – research protocol	1
3.	-	-
4.	-	-
5.	-	-
6.	-	-
7.	-	-
8.	-	-
9.	-	-
10.	-	-

1 class = 45 minutes

Literature

1. Knezevic A, Ilie N, AlSamman R, Phark JH, Duarte S, Jr. Polymerization: scientific background and clinical protocol for light-curing indirect bonded restorations. Quintessence Dent Technol 2020;43:34-48.

2. Price RBT. Light Curing in Dentistry. Dent Clin North Am 2017; 61(4):751-778.
3. Rueggeberg FA, Giannini A, Galvao Arrais CA, Price RBT. Light curing in dentistry and clinical implications: a literature review. Brazilian Oral Res 2017; 28(31 suppl 1):e61.
4. Price RB, Rueggeberg FA, Labrie D, Felix CM. Irradiance uniformity and distribution from dental light curing units. J Esthet Restor Dent 2010 Apr;22(2):86-101.
5. Price RB, Labrie D, Rueggeberg FA, Sullivan B, Kostylev I, Fahey J. Correlation between the beam profile from a curing light and the microhardness of four resins. Dent Mater 2014;30(12):1345-57.
6. Harlow JE, Rueggeberg FA, Labrie D, Sullivan B, Price RB. Transmission of violet and blue light through conventional (layered) and bulk cured resin-based composites. J Dent 2016;53:44-50.
7. Mutluay MM, Rueggeberg FA, Price RB. Effect of using proper light-curing techniques on energy delivered to a Class 1 restoration. Quintessence Int 2014; 45(7):549-56
8. Price RB, Labrie D, Rueggeberg FA, Felix CM. Irradiance differences in the violet (405 nm) and blue (460 nm) spectral ranges among dental light-curing units. J Esthet Restor Dent 2010;22(6):363-77.
9. Tarle Z, Knezevic A, Demoli N, Meniga A, Sutalo J, Unterbrink G, Ristic M, Pichler G. Comparison of composite curing parameters: Effects of light source and curing mode on conversion, temperature rise and polymerization shrinkage. Oper Dent 2006; 31(2):216-26.
10. Knezevic A, Demoli N, Tarle Z, Meniga A, Sutalo J, Pichler G. Measurement of linear polymerization contraction using digital laser interferometry. Oper Dent 2005; 30(3):346-352.
11. Knezevic A, Sariri K, Sovic I, Demoli N, Tarle Z. Shrinkage evaluation of composite polymerized with LED units using laser interferometry. Quintessence Int 2010; 41: 417 -25.
12. Knezevic A, Zeljezic D, Kopjar N, Tarle Z. Influence of curing mode intensities on cell culture cytotoxicity/genotoxicity. Am J Dent 2009; 22: 43-48.
13. Cramer NB, Stansbury JW, Bowman CN. Recent advances and developments in composite dental restorative materials. J Dent Res 2011;90:402-16.
14. Lucey SM, Santini A, Roebuck EM. Degree of conversion of resin-based materials cured with dual-peak or single-peak LED light-curing units. Int J Pediatr Dent 2014:1-10.
15. Haenel T, Hausernova B, Steinhaus J, Price RTB, Sullivan B, Moeginger B. Effect of the irradiance distribution from light curing units on the local micro-hardness of the surface of dental resins. Dent Mat 2015;31:93-104.
16. Santini A, Gallegos IT, Felix CM. Photoinitiators in dentistry: A review. Prim Dent J 2013;2:30-3.
17. Platt JA, Price RB. Light Curing Explored in Halifax. Oper Dent 2014;39:561-3.
18. Pubmed – ključne riječi: curing lights, LED, monowave/single peak LED, polywave/dual peak LED, beam profile, degree of conversion, polymerization shrinkage, polymerization stress, temperature increase, cytotoxicity/genotoxicity

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

Alena Knezevic Cizmic graduated from the School of Dental Medicine, University of Zagreb in 1996. From 1997 she worked as a Scientific Junior Researcher at the Department of Dental Pathology, School of Dental Medicine in Zagreb. The same year she completed her internship at the same school and received her dental license. In 1999 she achieved the title Master of Biomedical Science and she was promoted in the title of Scientific Assistant at Department of Dental Pathology, School of Dental Medicine in Zagreb. She completed her PhD thesis and achieved the title of Doctor of Biomedical sciences in dentistry in 2002, and in 2003 she was promoted in the title of Higher Scientific Assistant. In 2004 she completed her residency in Endodontics and Restorative Dentistry. In 2005 she was promoted in the title of Higher Scientific Associate and in 2006 in the title of Scientific Associate at the Department of Endodontics and Restorative Dentistry. She was a participant in the scientific

projects "Materials in the hard tooth tissue reconstruction", "Nanostructure of restorative materials and interaction with hard tooth tissue", "Development of technological principles for long lasting adhesive restorations", and on the project "A prospective, observational study of Implantium implants in immediate occlusal loading after insertion", Herman Ostrow School of Dentistry, University of Southern California, Los Angeles.

Alena Knezevic actively participated in clinical and preclinical teaching and in lecturing in Continuing education courses. She is an author and coauthor of more than 110 scientific, review, and clinical articles. She actively participated in many European and world dental meetings, as well as numerous domestic professional dental meetings and hands on courses.

Her scientific and clinical work is mostly related to the field of dental materials for hard tooth structure reconstruction. In 1996 she received the award "Lek" Zagreb for research in the field of dental materials. In 2005 she was awarded with the award of Society of University teachers and other scientists in Zagreb with the yearly award "Society of young researchers and artists". In 2007 she received the award at the University of Southern California Research Day for the best work in the post-PhD category.

She is a member of the Croatian Dental Chamber, Croatian Endodontic Society, American Dental Education Association, European Society of Endodontics and is a former member of the American Association for the Advancement of Science and International Association for Dental Research – Dental Materials Group.

She was on several internships in Vivadent, Lichtenstein, University of California Los Angeles (UCLA), Los Angeles, Ludwig Maximilian University, Munich, University of Southern California (USC), Los Angeles, and in the Institute of Composite Materials, Los Angeles (USC).

In 2014 she left the School of Dental Medicine University of Zagreb and she continued her work at the Department of Restorative Science at the Herman Ostrow School of Dentistry of USC, University of Southern California, Los Angeles, as an Assistant Professor. In 2019 she was promoted to Associate Professor at the same department.

She is teaching clinical and pre-clinical classes in Restorative and CAD/CAM dentistry for DDS students, ASPID and Advance Operative and Adhesive Dentistry students. She is the director of the pre-clinical module, Operative and Esthetic Dentistry for DDS students, and co-director of the preclinical module Cariology and Microdentistry for DDS students, Operative Dentistry and Cariology for ASPID students, and Applied Adhesion Sciences for Advanced Operative and Adhesive Dentistry residents.

She is the facilitator in seminars for residents in Advanced Operative and Adhesive Dentistry: Digital Technology Applied to Dentistry and Operative Dentistry and Biomaterials Literature Review.

She is author of more than ten children pictures books and she is a Croatian language teacher at St. Anthony's Croatian children school in Los Angeles. She is married and a mother of two children.