Experimental denture base resins: The influence of electron beam post-curing.

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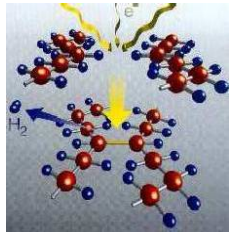
Introduction:

Since the basic investigations of Charlesby, electron beam irradiation has been used as a method to influence the properties of polymers. Ionizised irradiation of polyethylene introduced chain linkage which results in a insoluble and more heat-resistant polymer. Generally, two types of reactions exist with electron beam irradiation, which compete during radiation: chain linkage or breakage. Therefore the question arises, whether electron beam post-curing is able to improve the mechanical properties of different denture base materials.

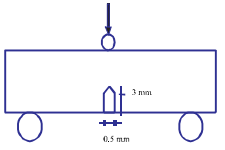
Electron beam accelerator Rhodotron;
With the courtesy of BGS BETA-GAMMA
Service, Saal a.d. Donau, Germany

Materials and methods:

180 rectangular specimens (36x8x4mm) were manufactured from 6 different experimental denture base resins (**EDBR**): EDBR 1 and EDBR 2 were consisting of MMA (Mono-methyl-methacrylate). EDBR3 and EDBR4 were made of MMA/EGDMA (Ethylglycol-dimethacrylate) and EDBR5 and EDBR6 were consisting of MMA/BDDMA (Butandiol-dimethacrylate). 60 specimens (10 each group) were irradiated (BGS beta gamma service, Saal a. d. Donau, G) with 25 kGy and 60 specimens with 200 kGy in steps of 25 kGy each (4,5 MeV). 60 samples served as a control group. The means of fracture toughness (K1c) and Vickers hardness (VH) were measured from the control and the irradiated groups. Mann-Whitney U-test was performed (p=0.05).

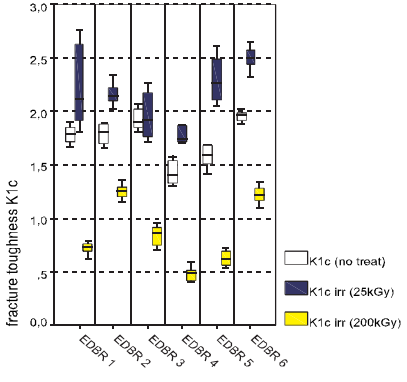


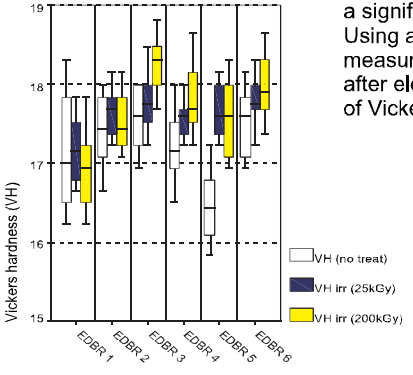
Principle of electron beam post-curing;



Three-point bending test to determine K1c

Results:





With the exception of EDBR 3 all tested experimental denture base polymers showed a significant increase of fracture toughness after electron beam irradiation with 25 kGy. Using an energy dose of 200 kGy a significant decrease of fracture toughness could be measured. EDBR 3, EDBR 5 and EDBR 6 had a significant higher Vickers hardness after electron beam irradiation with 200 kGy. Only EDBR 5 showed a significant increase of Vickers hardness, using 25 kGy.

Brand	EDBR1	EDBR2	EDBR3	EDBR4	EDBR5	EDBR6
K1c	1.79	1.81	1.89	1.36	1.60	1.96
K1c *irr 25 kGy*	2.11	2.14	1.92	1.74	2.27	2.50
K1c irr 200 kGy	0.73	1.27	0.86	0.50	0.62	1.23
VH	17.00	17.45	17.60	17.15	16.44	17.60
VH *irr 25 kGy*	17.15	17.68	17.76	17.60	17.61	17.75
VH *irr 200 kGy*	16.93	17.45	18.31	17.68	17.60	17.91

The means of fracture toughness (K1c) and Vickers hardness (VH)

Vickers hardness evaluation
(500g/60s)

Conclusion:

When electron beam irradiation with 25 kGy is performed, most of the irradiated experimental denture base resins tend to improve their mechanical properties. Especially EDBR5 and EDBR6 , consisting of Butandiol-dimethacrylate, show a significant increase in fracture toughness and Vickers hardness after electron beam post-curing (25 kGy, 4.5 MeV). Using electron beam irradiation with 200 kGy (4.5 MeV), the polymeric structure of all resins seems to be destroyed. Therefore only low energy electron beam irradiation (25 kGy) seems to induce an additional chain linkage.

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