Structural Investigation Concerning Mechanical Behaviour of Two Dental Acrylic Resins

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Mechanical behaviour of removable partial dentures is a priority among experimental papers, in order to define the fracture mechanism of acrylic resins. Present paper presents experimental results concerning mechanical behaviour of two different dental acrylic resins, respectively Meliodent and Royaldent. There are determined mechanical characteristics on Zwick Roell Equipment with testXpert system. The fracture samples were examined on stereomicroscope Olympus. The difference in mechanical behaviour is explained in terms of stereomicorscopic analysis.

Keywords: dental resins, removable partial denture, stereomicroscopy, fiber, composite material

Spectaculars development in dental techniques for repairing oral teeth was permanently based on intensive utilization of different materials. Starting from existing materials in nature as bone, wood, metals and then alloys (gold, silver, stainless steel, cobalt-chromium, titanium), in our days based on intensive techniques, some new and performed materials may be used, as polymers (rubber, resins), up to composite materials based on acrylic resins reinforced with fibers. In XIX-th century plastic materials became favorites (1843- Redtenbacher, acrylic acid, 1901- Rohm and 1093 Bawer- acrylates). Today, those resins are replaced either with acrylic resins (with acceptable properties, simple technology, but with disadvantages such as dimension changes during elaboration, porosities, reduced thermal conductibility, poor mechanical resistance, low biological properties), or to resins such as: diacrylic, polyacetil (polymethaethilene). Utilization of these resins is based on their ideal properties: esthetic properties (Translucidity, color near to the replaces tissues color and maintaining color both during elaboration and inside human mouth) and physical- chemical properties (dimension stability and maintaining the shape during processing and inside human mouth, good elasticity, wear resistance in human mouth, impermeability for saliva and food, good polishing and hygiene, good connection to the other prosthesis components, superior plasticity temperature than human mouth temperature, non toxicity and irritation the human tissue). According with EN ISO 1567 there are four types of resins: thermo polymerized resins (upper 65°C) (either bi-component, or mono-component), self polymerized (lower 65°C), thermoplastic resins in powder form, photo-polymerized and microwave polymerized resins. Thermo-polymerized resins are now the most used materials for realization of partial or total dental prosthesis. World market of bi-component thermo-polymerized resins know a lot of products, such as Paladon 65 (Heraeus Kulzer), Implacryl (Vertex), Superacryl (Spofa), Selectaplus (dentsply DeTey), Ivocap plus (Ivoclar) obtained by injection. One of the most difficult prosthetic restorations is that of total dentition, where the result may "be seen" immediately . A bad prosthesis can not be kept on the position and is nonstable from the first moment. Prosthetic restoration of total dentition must follow the recovery of dental arcades, functional almost partial mastication recovery, and why not aesthetic shape and form of teeth, oclusal reequilibration, homeostasis of the prosthesis field. The total prosthesis is a prosthesis inserted in human mouth, with some problems in patients' accommodation. Being mobile from mouth cavity is sometimes embarrassing, creating some physical handicap and infirmity.

Frequently, there are non corresponding situations (fig. 1), when partial removable prosthesis may have ruptures, producing partial or total breakdown. The problem of mechanical behavior of acrylic resins materials is a real one, being well and repeatedly presented in literature [1-10]. The necessity of a minimum level of mechanical characteristic values guarantee may appear in order to ensure the prosthesis viability on long term. The aim of present paper is the necessity of processes grounding which take place for integration maintaining of bicomponent thermopolimerized resins, and also to structural characterization of two types of resins, with differential behaviour.

Experimental part

There were analysed two acrylic resins which are ussualy used in dental practice, respectively: Meliodent (type Heraeus Kulzer, Germany) and Royaldent Plus (type Palatinal Foggyart Budapest, Hungary). In accordance with dental practice, there were made by polymerization bands with the following dimensions: 2mm thickness, 30 mm length and 5 mm breadth. The macroscopic aspect of tested samples is given in figure 2, where M is Meliodent and R is Royaldent.

Mechanical characteristics were determined by Zwick Roel equipment with data processing using testXpert system. The loaded stress was 50kN and the rezolution 0.1mm for all experiemental samples. The experimental samples were then analysed at stereomicroscope Olympus type SZX7, equiped with image processing soft QuickphotoMicro 2.2. There were analysed both longitudinal and transversal surfaces perpendicular to fracture surface.

Results and discussions

Results concerning the mechanical behaviour of the experimental samples of the two acrylic resins are

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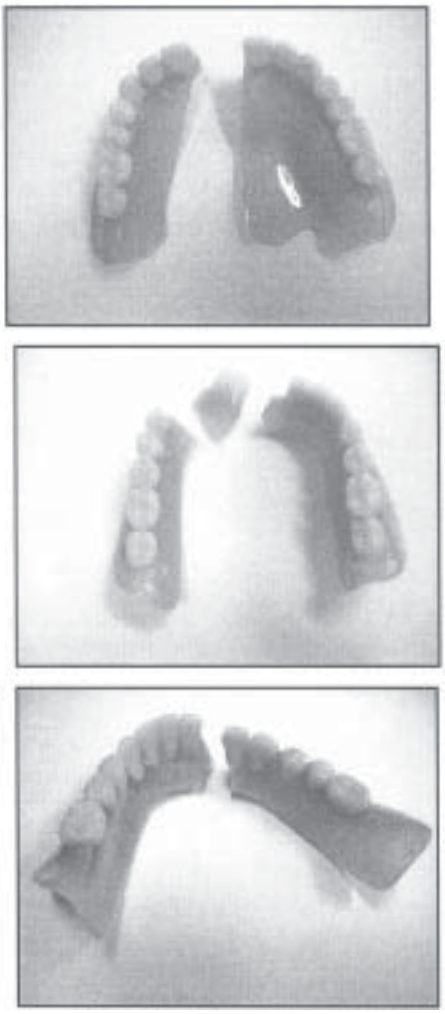


Fig. 1. Macrostructural aspects of different broken partial removable dentures

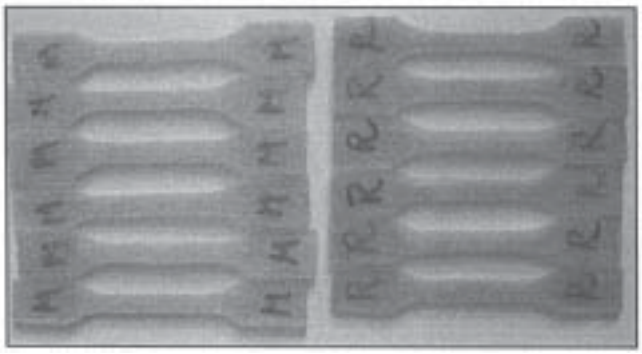
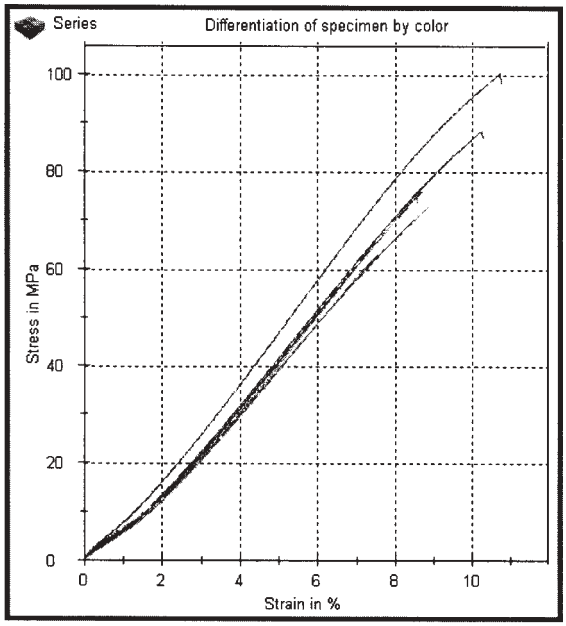
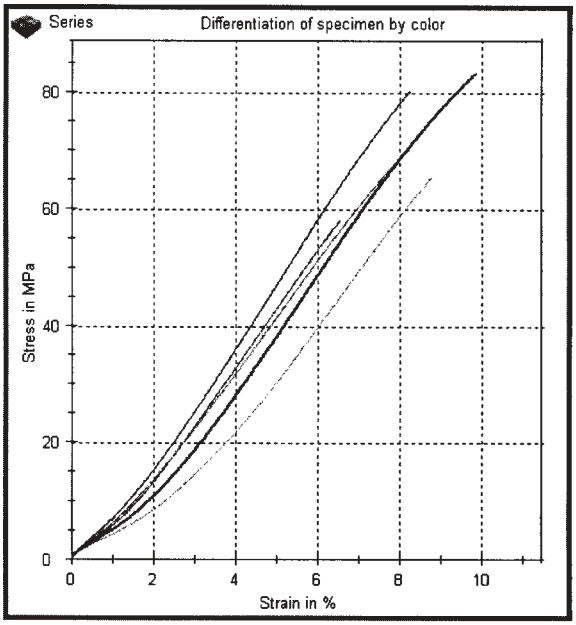


Fig. 2. Macroscopic aspect of tested samples



a



b

Fig. 3.Hooke curves aspect of Meliodent resin (a) and Royaldent resin (b)

comparatively given in graphs from figure 3a (for Meliodent) and figure 3b (for Royaldent).

One may remark that the mechanical characteristics of M samples are with about 13-16% lower than mechanical

Table 1

EXPERIMENTAL RESULTS CONCERNING MECHANICAL CHARACTERISTICS OF DENTAL RESINS

Sample	Mechanical Characteristics						Average Values		
	E, MPa	$R_{p0,1}$ MPa	$R_{p0,2}$ MPa	$R_{p0,2}/R_m$ %	R_m MPa	A_5 %	E, MPa	R_m MPa	A_5 %
M1	983	2	3.42	6.26	54.53	1.0	991.6	65,8	2.5
M2	1077	2	3.35	5.23	64.2	2.0			
M3	1288	2	3.63	4.88	74.4	2.5			
M4	1234	2	2.18	3.62	60.3	3.5			
M5	1261	2	2.41	3.18	75.9	3.5			
R1	882	3	4.45	5.55	80,19	2.0	1122.8	75.3	2.9
R2	1075	3	4.60	6.87	66.8	2.5			
R3	972	3	3.38	4.83	69.7	2.0			
R4	1148	3	3.75	5.43	69.2	3.0			
R5	1537	3	4.17	4.60	90.0	5.0			

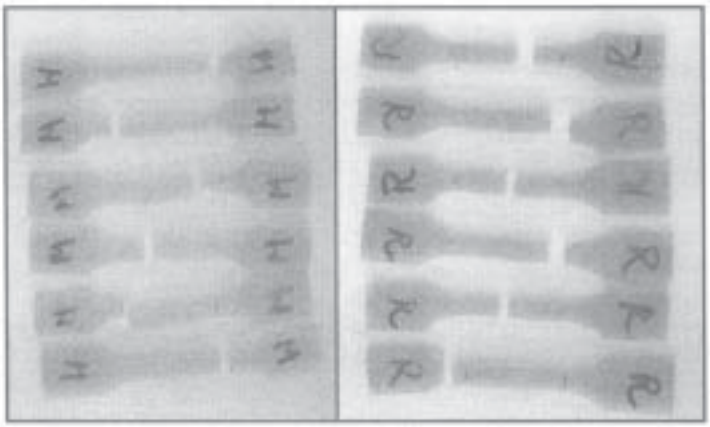


Fig. 4.The aspect of broken samples from the two dental experimental resins

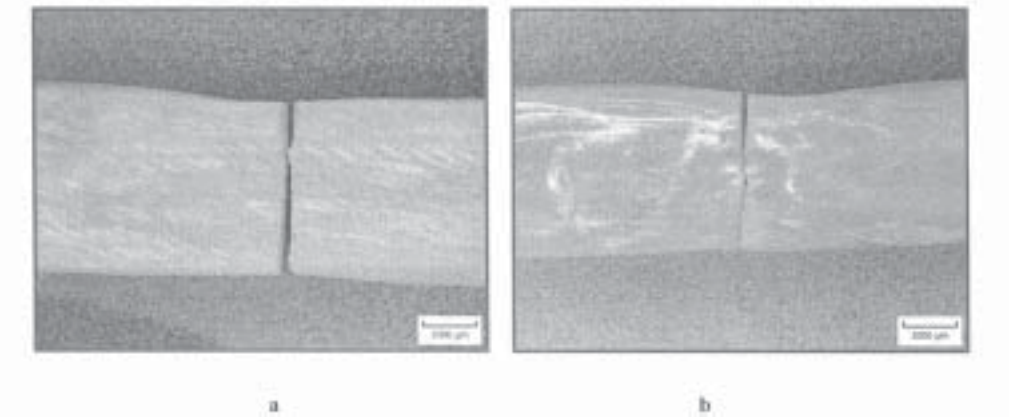


Fig. 5.The stereomicrostructural aspect of the tested samples in longitudinal section: a-Meliodent, b- Royaldent

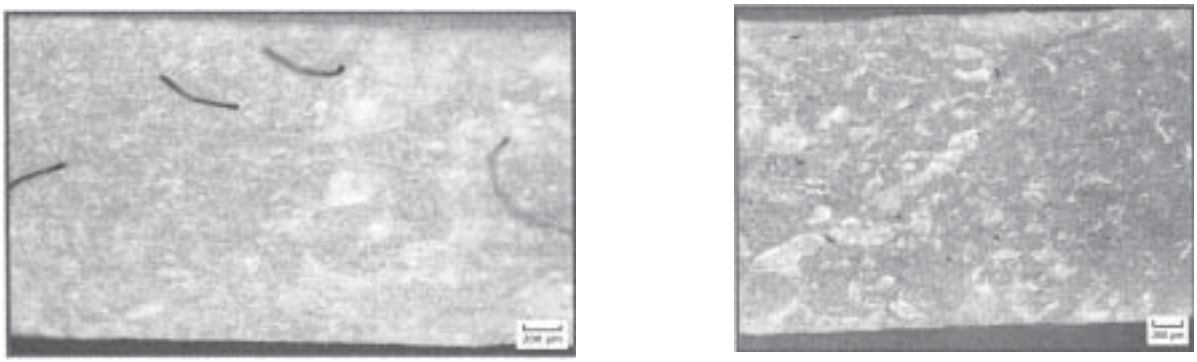


Fig. 6.The stereomicrostructural aspect of the tested samples in transversal section: a-Meliodent, b- Royaldent

characteristics of R samples. Also, R samples may have an elongation up to 1mm in comparison with initial sample, which may indicate a ductile behaviour to fracture. The results are in accordance with the observations obtained at stereomicroscope (figs. 5, 6).

So, in longitudinal section, M samples do not have elongation, the final fracture being sudden (fig. 5a), in opposite with R samples, which have a significant elongation before fracture (fig. 5b). In transversal cross section, one may remark that dark reinforced fibers from M composite (fig. 6a) is not broken together with polymeric matrix, in opposite with R samples, where both matrix and fibers are broken in the same time (fig. 6b). The different behaviour of fracture of these two composite materials, based on acrylic resins may explain the differences between mechanical characteristics of fibers and polymeric matrix. If in case of M samples, mechanical characteristics of fibers are higher than of matrix, in case of R samples, these characteristics are the same. So, R samples have a better behavior to fracture than M samples, which may explain both high level of the mechanical characteristics and also ductile behaviour.

Conclusions

Comparative analysis of fracture behaviour for two dental acrylic resins type Meliodent and Royaldent may reveal the following aspects:

- mechanical characteristic values of samples were in different ranges: ultimate strength is 54-75MPa for Meliodent in comparison with 69-90MPa for Royaldent; Young modulus of elasticity is 983-1288 MPa for Meliodent in comparison with 882-1537 MPa for Royaldent and elongation is 1-3.5% for Meliodent in comparison with 2-5% MPa for Royaldent;
- royaldent samples may have a significant elongation before fracture, in comparison with Meliodent samples, which may be a sign of a ductile behaviour;
- different behavior of two dental acrylic resins Meliodent and Royaldent is due to significant differences between mechanical characteristics of reinforced fibers and matrix. At Meliodent samples fibers may not fracture in the same moment with matrix, in opposite with Royaldent samples, where fibers and matrix are broken simultaneously.

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