Development of new hybrid indirect composite resin for crown-TWiNY (Part1) Fundamental properties /

Kato T, Hoshikawa T (Yamamoto Precious Metal Co., Ltd.): The purpose of this investigation was to measure and compare the fundamental properties (flexural strength, hardness, polymerization shrinkage, water absorption, solubility, change in transmittance under polymerization, radiopacity) of the new trial and the four commercially available hybrid resins. The fundamental properties of the trial and the commercial resins have sufficiently satisfied the values stipulated in ISO 10477. In the trial resin, the change of transmittance was very small and the mechanical strength was excellent.

[Abstract]
Among many other demands they face, indirect composite resins are required to exhibit sufficient mechanical strength for use on molars, achieve reproduction of natural tooth aesthetics, and support x-ray radiopacity.

In this investigation, newly-developed aggregated inorganic filler with an adjusted refractive index was synthesized using the sol-gel process to develop highly-functional indirect composite resin, TWiNY[1). This investigation measures and reports the basic physical properties of the trial resin in comparison with the four main commercially available indirect composite resins. The physical properties measured were: flexural strength, hardness, polymerization shrinkage, water absorption, solubility, change in transmittance under polymerization, and radiopacity.

[Materials and Methods]
The experiment was conducted on a newly-developed DA3 material (Yamamoto Precious Metal Co., Ltd; hereinafter the “test subject”) and four commercially available DA3 materials, *A*, *B*, *C*, and *D*.

1) Physical properties: Flexural strength, hardness, water absorption and solubility were measured in accordance with the ISO 10477 standard.

2) Polymerization shrinkage: Density measurement was performed before and after polymerization curing, and the degree of polymerization shrinkage was then calculated.

3) Change in transmittance under polymerization: Change in transmittance under polymerization was measured in resin (Trans shade) before and after photo polymerization, using a turbidity meter (Haze Meter HDH2000).

[Results and Discussion]
The inorganic content by percentage and fundamental physical properties obtained under firing at 650°C are given in Table.

Table: Evaluation Results of Fundamental Physical Properties

	Test subject	*A*	*B*	*C*	*D*
Inorganic content by percentage [wt%]	76.5	88.6	70.8	67.8	78.5
Flexural strength [MPa]	239	218	194	165	186
Hardness [Hv0.2]	107	163	85	71	117
Polymerization shrinkage [vol%]	2.5	1.5	2.9	3.0	2.5
Water absorption [$\mu g/mm^3$]	14.3	10.7	24.2	25.3	11.0
Solubility [$\mu g/mm^3$]	0.1	0.2	0.3	0.5	0.3
Transmittance after polymerization [%]	65.1	75.1	70.0	68.6	61.5
Difference in transmittance values before and after polymerization [%]	+2.0	+21.4	+18.0	−2.0	+5.3

Inorganic content by percentage showed values from 89 wt% (*A*) to 68 wt% (*C*); the values achieved demonstrated close correspondence with hardness and polymerization shrinkage.

The ISO 10477 standard for hard resins stipulates flexural strength at 50Mpa and over, hardness at 18HV0.2 and over, water absorption at 32μg/mm^3 or less, and solubility at 5μg/mm^3 or less. As the Table demonstrates, the flexural strength of indirect composite resins (168~238Mpa) exceeds the ISO standard by over three times, while hardness (71~163 HV0.2) does so by a factor of over four. All indirect composite resins tested comfortably exceeded stipulated values for water absorption and solubility, also.

With reference to the four commercially-available indirect composite resins only, the results recorded in the Table also indicate that their flexural strength and hardness depend on their level of filler content by percentage. On the other hand, while the filler content by percentage of the test subject ranked third after *A* and *D*, its flexural strength displayed the highest value recorded; the test subject utilizes inorganic coagulant filler, and it is thought that the flexural strength of the resin which forms its complex is influenced by the shape of the filler particles, apart from its filler content by percentage.

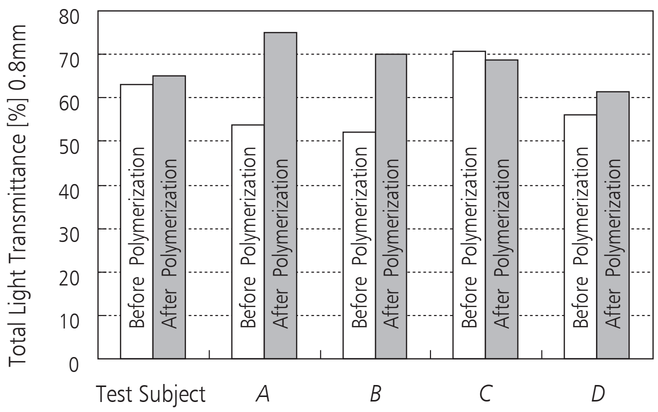

Figure: The influence of resin polymerization on changes in transmittance under total light transmittance

In terms of its use as a material in the restoration of the dental crown, aesthetics have emerged as a major issue in addition to the unavoidable question of its durability under conditions of mastication and digestion. The Figure shows the change in total light transmittance before and after polymerization of all the resins tested.

The transmittance levels after polymerization (dental prosthesis retention) were high at 61-75%, with exterior appearance pitched at an aesthetic level intended to reproduce the appearance of natural tooth enamel. Also, the difference in transmittance (here essentially equivalent to color tone) after polymerization between the test subject and *C* was minor, attesting to a straightforward approach toward color adjustment in the manufacturing process for these prosthetics. In other words, the degree of transmittance was determined by the balance between the respective refractive indexes of the filler of which the resin is composed and the matrix (before and after polymerization). It is considered that the refractive indexes of both the test subject and *C* display values exactly between those of the filler and matrix before and after polymerization. Therefore, we have established that radiopacity depends on the refractive index of the matrix (polymer).

From the results obtained above, it is clearly established that the fundamental properties of the test subject, along with those of the four commercially-available resins tested, comfortably meet the stipulations required under the relevant ISO standard. The newly developed resin displayed minor variation in degree of transmittance (color tone) before and after polymerization, and is confirmed to be a indirect composite resin exhibiting excellent mechanical strength.

[Reference]
1) Hoshikawa T, Miyazaki A, Kato T, Anraku T, Yamamoto S: Japanese Patent Number: 4502673