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Electroforming in Dentistry
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Fig. 23
Sagittal section through an electroformed crown. The thin (0.2 mm) layer of metal leaves sufficient room for the ceramic layers (opaquer, dentin and enamel).

The electroforming process takes 10 to 12 hours and applied gold in an even layer .2 to .4mm thick. The framework has a Vickers harness of 150 (VH 50 after firing) and consists of 99.8% fine gold. It is homogenous and requires no oxide layers for adhesion of ceramics. All commercially available ceramic materials can be used for firing. The bond between ceramic and fine gold is provided chiefly by gap-free adhesion.

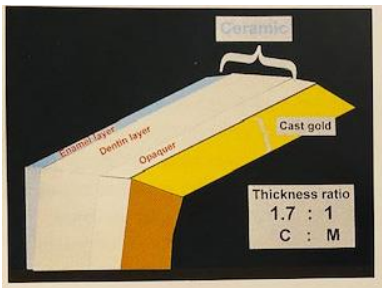

Fig. 24
Schematic depiction of the space relationship of metal to ceramic in a metal-ceramic restoration with a cast metal base. The ratio of ceramic to metal is

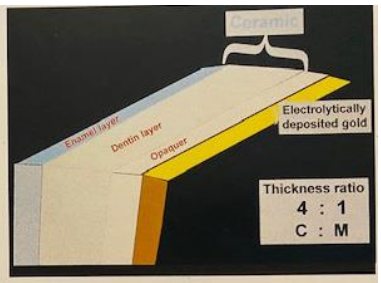

Fig. 25
Space relationship in an electroformed crown. The ratio is 4:1.

In summary, these are the advantages of the electroformed single crown restoration:

- hard tissue-sparing (pulp protecting) tooth preparation
- high precision of fit
- can be luted with zinc phosphate cement
- involves only biocompatible materials (ceramic and gold, without need for oxide layer)
- major ceramic component (esthetics and finish)
- gold color of the coping
- offers broad indications for use (anterior and posterior regions)
- favorable costs of fabrication.

Table 1
Evaluation of various types of single crowns. The electroformed crown takes first place.

	Space required	Precision of fit	Luting quality	Biocompatibility (crown)	Biocompatibility (luting material)	Esthetics	Fabrication cost	Long-term prognosis	Score	Rank
Full cast crown	+++	++	+++	++	+++	(-)	+++	+++	18	3
Composite veneer crown	++	++	+++	++	+++	++	++	++	18	3
PFM crown	++	++	+++	++	+++	++	++	+++	19	2
Electroformed crown	**+++**	**+++**	**+++**	**+++**	**+++**	**+++**	**++**	**++**	**22**	**1**
Empress crown	+	++	++	+++	++	+++	+	++	16	4
In-Ceram crown	+	++	+++	+++	+++	+++	+	++	18	3
Procera crown	++	+	++	+++	+++	++	+	++	16	4

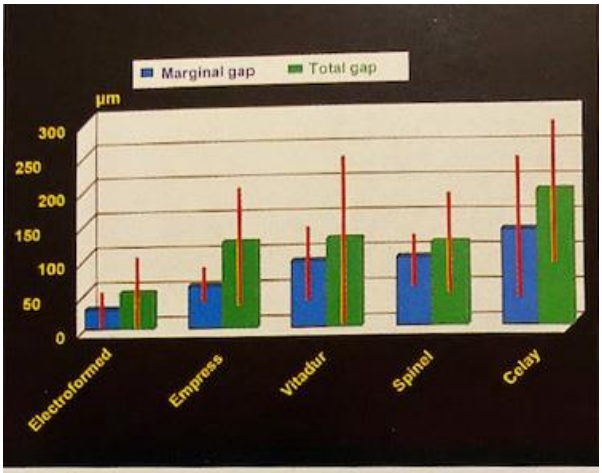

Fig. 27
Average marginal gap width and standard deviations of various ceramic inlay/onlay systems.[12, 21]
Blue, superficial gap;
Green, 3-dimensional within the cavity.

Electroformed gold has no flaws, porosities or impurities.

In 1989 the first electroformed unit in Germany.

The gold weight required for crowns is .4 to .6g; for inlays and onlays .2 -.9g. The melting point is 1063 degrees C. Electroforming required a gold bath and the gold is dissolved in a quaternary ammonium complex: $(NH4)_3Au(SO_3)_2$.

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Chapter 3.4 Manfred Busch: "Combination Prosthetics with and without implants"

"Galvanically deposited gold has a Vickers Hardness of approximately 100 owing to its lattice structure. This hardness can be retained by securing the secondary and tertiary structures. By veneering with high quality ceramic, tempering of the electro-formed structure also should be avoided. " …"If galvanically precipitated metals are exposed to thermal treatment, e.g.; by soldering, casting, or annealing, the galvanically precipitated lattice recrystallizes and the hardness drops to 50 (like fine gold)."

"Combination prosthetics in conjunction with implants places high demands on the dental technician because the bone-anchored implants, in contrast to the natural teeth are rigid. For that reason, even very minor deviations in the superstructure lead to imprecision of fit on the implant abutments."

It is interesting that certain metals have a better, other metals a lesser, sliding capability. High palladium alloys as well as nonprecious metals have rather "sticky" properties; high gold alloys and titanium, in contrast, have better sliding qualities…

The sliding properties of galvanic gold layers are important for many applications. Galvanic gold is used for switch contacts and plug connectors due to its sliding property and high wear resistance. Electroformed gold layers are also used as a lubricant in the space industry.

Fixed Prostheses by Electroforming Gabriele Diedrichs 4.1 p. 178.

"The spectrum of indications for fixed prosthetics includes inlays, onlays and partial crowns, single crowns for the anterior and posterior regions, and short-span partial dentures.

"A coping of an electroformed crown requires only approximately 60% of the material needed to produce a higher-gold-alloy coping. The rare raw material gold is used sparingly, and for comparison, the precious metal cost is not greater than that of a high-gold alloy.

"Depending on the procedure, the use or adhesive oxides for metal-ceramic bonding may be eliminated, and only new material can be used. Contrary to casting of dental alloys, the utilization of waste (e.g of casting sprue canals, etc.) is not possible. Voids, air bubbles, and impurities that may be created by the sprues during the casting operation cannot occur. The purity of the material used therefore is guaranteed – an important aspect from the medical and forensic points of view."

"The special quality of electroformed restorations results from the combination of monometallic gold and the fabrication technology. Even it, during firing of the ceramic, the micro-fine lattice structure of the deposited pure gold recrystallizes as a result of the

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diminishing internal strains, the grain size remains only one eighth that of cast gold, not to mention the presence of unavoidable porosities and potential impurities." Cast gold cannot be compared to electrolytically deposited pure gold in any way.

"Overcontouring the crown margin (crown edge too thick and hanging over) is a condition found frequently in veneered crowns. Spiekermann found overcontouring in 71% of the crowns examined in 70 jaw preparation." "Extremely thin pure-gold margins (only 100 to 200um thick) in combination with preparations without beveled margins clearly present fewer problems with regard to optimal margin design than do crown margins of conventional metal-ceramic restorations and leave little to be desired esthetically. The soft-yellow, pure-gold tone of the electroformed fixture optimally provides an excellent transition between the restoration and the gingiva as well, and is an ideal base for ceramic veneering with its exemplary natural color esthetics."

"The quality of the coronal marginal seal is considered to be a determining factor for plaque accumulation and an important parameter for the health of the periodontal tissues.

"Compared to other types of crowns (full cast crowns and metal-ceramic crowns with oral metal surfaces) and comparable healthy teeth, the fewest plaque deposits were found with electroformed crowns." Pl 182

Combination Prostheses with Electroformed Telescopic/Conical Crowns Jakob Wirz

"Telescopic prostheses have been among the proven therapies practiced in modern dental prosthetics."

Material and Technological Aspects Michael Happ Chapter 5

"Theories of metal-ceramic bonding assume that, in the formation of electroformed constructions, an optimal bond between the ceramic and the metal is achieved by means of an oxide film."

Because pure gold by itself has no tendency to oxidize…a gold bonding agent containing ceramic particles provides and intermediate step. The bonding agent consists of ceramic particles and finer gold spheres. The material must be mixed before use since phases tend to separate.

Clean and roughen he surface with sandblasting—not greater than 2 bar pressure and particle size not smaller 125um. Brush on the bonding agent, dry in a kiln and fire. The drying process cannot be too quick.

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During firing, the gold particles fuse and flow together and engulf the ceramic particles. The bond is partly mechanical. After firing the coping with have a matte gold color.

A basic principle of metal-ceramic systems is that the thermal expansion of the metal should be greater than that of the ceramic. The difference in thermal expansion during the cooling process produces tension that, together with the tension-induced strength of the ceramic, lead to stabilization of the bond."

"Except for the placement of the bonding agent, the course of treatment and the dental laboratory processing sequence are identical conventional metal-ceramic technology. Only the electroforming of the metal frame is an exception."

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Fig. 30b
Working cast with prepared bridge abutments.

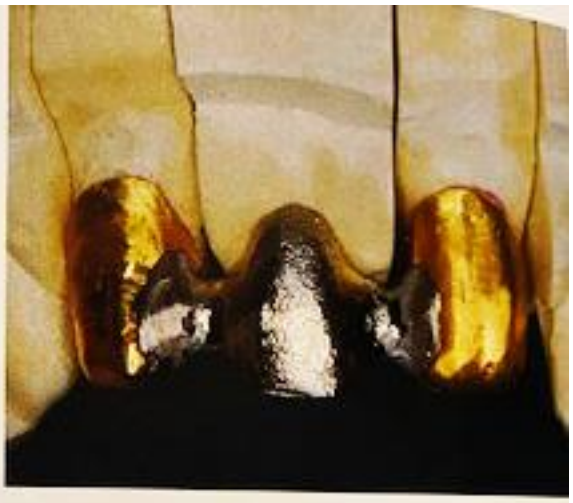
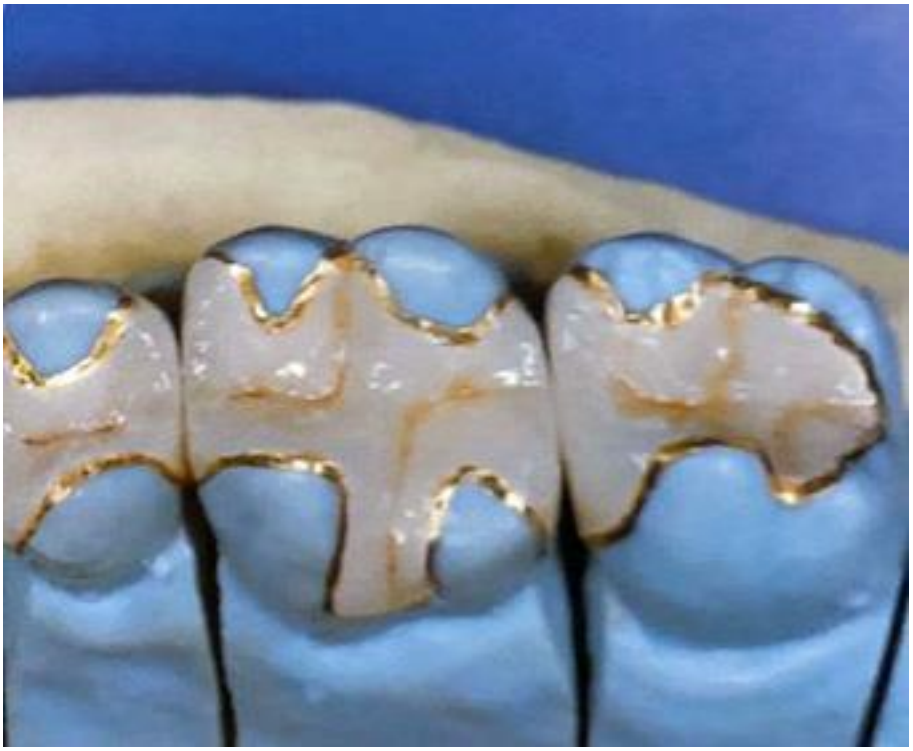


Fig. 30c
Bridge foundation, electroformed copings with precious metal pontic laser welded in place.



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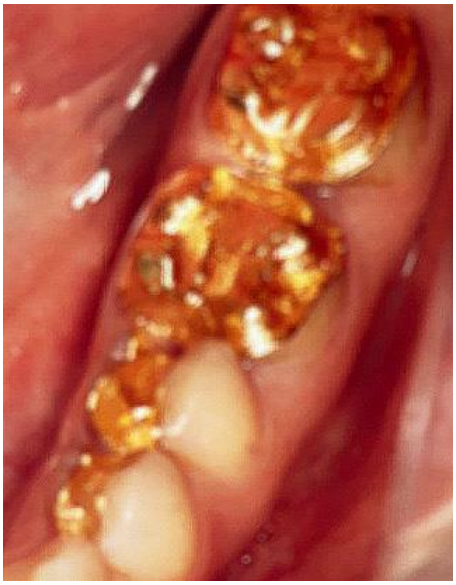

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