NUMERYS GF

WHITE PAPER

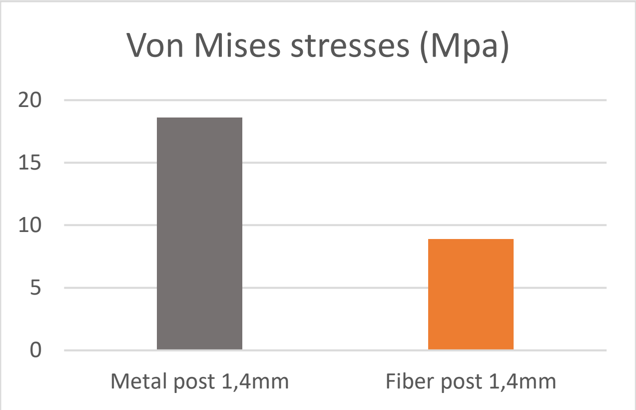
Introduction

Restoration of damaged anterior teeth has long been a challenge in terms of mechanical performance and aesthetics. Indeed, endodontically treated teeth often have extremely thin coronal tooth structure left after root canal therapy and restoration preparation. [1] As such, they require a post-and-core to support the definitive restoration. [2]

Traditional Post-and-core

Direct Restoration: Prefabricated post + core build-up material.

For many years, metals posts, both noble and nonnoble allows, were used as intra-radicular retention for endodontically treated teeth. [3-4]
The prefabricated post is directly placed inside the tooth and the core section is built using a luting cement in order to obtain the final post-and-core system.



However, the huge elastic modulus difference between metal post and dentin lead to nonuniform stress distribution and subject the tooth to excessive masticatory loads, resulting in irreparable root fractures. [5-6-7]

For this reason, prefabricated glass fiber posts have recently replaced metal posts, as their elastic modulus is closer to dentin, they are more aesthetic, and they can be bonded to dentin using resin cements. [8]

Different factors define the final performances of glass fiber posts: [9-10-11]

Factors
Composition of the material
Type of fibers
Diameter
Fiber/matrix homogeneity and impregnation
Fibers positioning and orientation
Elastic modulus
Flexural strength
Surface treatment

Apart from endodontic problems, the primary cause for failure include crown dislodgement, post debonding (60%) and marginal gap. [12]

Indeed, the use of prefabricated glass fiber posts may result in excessive amounts of resin cement to replace lost structure, reducing the overall resistance of the post-and-core system [4] [13]

A study by Kremeier et al demonstrated that thicker layers of cement increase the risk of shrinkage, resulting in a lower bond strength. [14]

Indirect restoration: cast post-and-core

As described by Muttlib *et al.* the adaptation of the prosthesis is one of the aspects to be taken into consideration. Adaptation is defined as the degree of fitting between the prosthesis and supporting structures. [15–16]

A poorly adapted prosthesis creates space within the root canal, making the tooth more prone to fracture. It can also lead to infiltration and microleakage if the cementation is insufficient by the formation of a marginal gap. [17-18-19]

According to a 10-year retrospective study by Balkenhol *et al,* the fit of a cast post-and-core influences the survival probability. [20] In this sense, a well-adapted post-and-core that fits the tooth anatomy can reduce the risk of debonding known to lead to failure. [21]

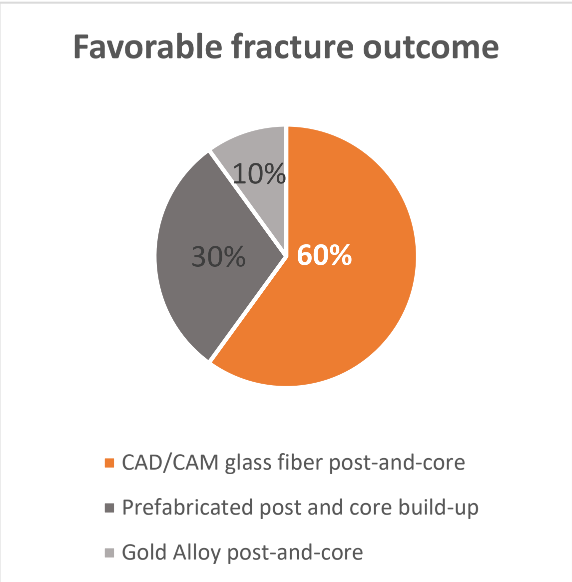
However, cast metal post-and-cores used with all-ceramic crowns fail to achieve a satisfactory aesthetic result due to the greyish discoloration caused by the metal substructure and frequent darkening of free gingival margin. [22-23]

Moreover, it is now well known that the materials used to restore endodontically treated teeth should have physical and mechanical properties similar to dentin. [3] As actual post-and-cores possess very high elastic moduli and are very rigid, they increase the risk of root fracture.

Future indirect restoration: CAD/CAM post-and-core

A clinical report has shown that using a CAD/CAM system was better than a prefabricated post and core build-up material for the treatment of severely damaged anterior tooth. [24]

The advantage of this system is obtaining a single-piece post-and-core, without the creation of interfaces between the post and composite resin. This process allows a minimum thickness of cement and eliminates the necessity to build a core section using a resin build-up material.



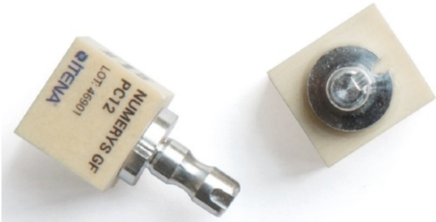
Another study has shown that compared with conventional methods, CAD/CAM integrated glass fiber post-and-core restoration reduced the occurrence of irreparable root fractures [7]

However, the only available materials are composed of multi-directional oriented fibers, which in the end did not show higher mechanical resistance than traditional glass fiber posts composed of unidirectional fibers. [26]

Indeed, Dyer et al. have shown that lowest mechanical resistance was obtained in diagonally oriented fiber composite and that the unidirectional oriented glass fiber composite showed the highest resistance to fracture. [10]

Product description

NUMERYS GF is a patented innovative glass fiber composite range designed for CAD/CAM technologies. The product is available in chairside PC12 blocks and laboratory disks.



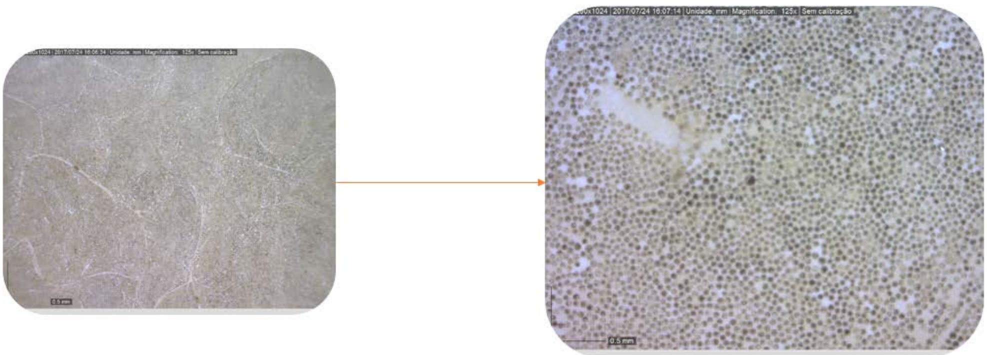
Indications

NUMERYS GF is indicated in the preparation of mono-radicular post-and-core elements for the reconstruction of pulpless teeth.

Advantages
Metal-free post-and-core system
Unidirectional oriented glass fibers
Radiopaque
Elastic modulus **similar to dentin**
Mechanical behaviour **similar to glass fiber posts**
Overall **higher mechanical performances**
Single-piece prosthesis
Simplified clinical procedure

Technical properties

NUMERYS GF blocks and disks are composed of **UNIDRECTIONAL** oriented glass fibers embedded in a resinous epoxy-matrix.



Glass fibers properties
Number of fiber inside a block = **700 000**
Number of fibers inside a disk = **22 800 000**
Average diameter of fiber = **20 µm**
Radiopaque

NUMERYS GF composition is similar to DENTOCLIC glass fiber posts, with a much higher quantity of fibers inside the composite, decreasing the material's rigidity even more and enabling a better elastic behaviour.

This is the result of an optimized manufacturing process based on our prefabricated DENTOCLIC glass fiber posts. [25]

Fibers direction

As direction of the fiber is one of the most important factors for mechanical resistance, NUMERYS GF is composed of unitary unidirectional oriented glass fibers.

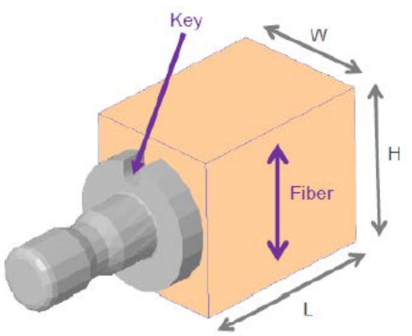
The disposition of the fibers are similar to prefabricated glass fiber posts and differs from multidirectional oriented glass fiber composites on the market. [26]

Multidirectional

Unidirectional

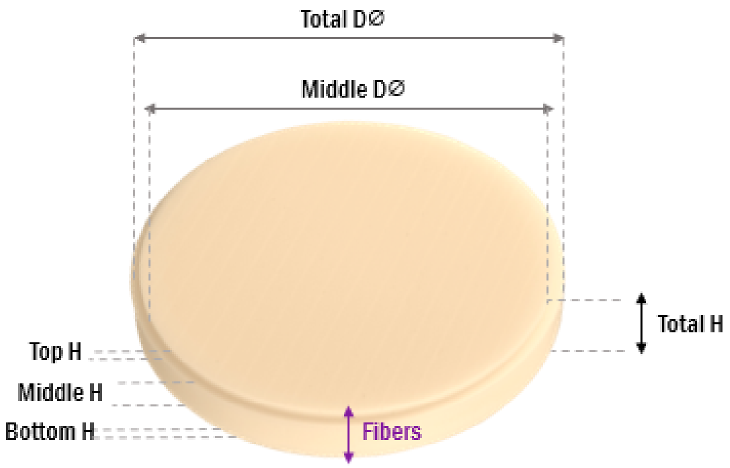
SEM observation of different glass fibers direction
(Cross-section x200 / x100)

NUMERYS PC 12 - Chairside



BLOCK SIZE	PC12 – NUMERYS GF
H (mm)	18
W (mm)	16
L (mm)	15

NUMERYS DISK - Laboratories

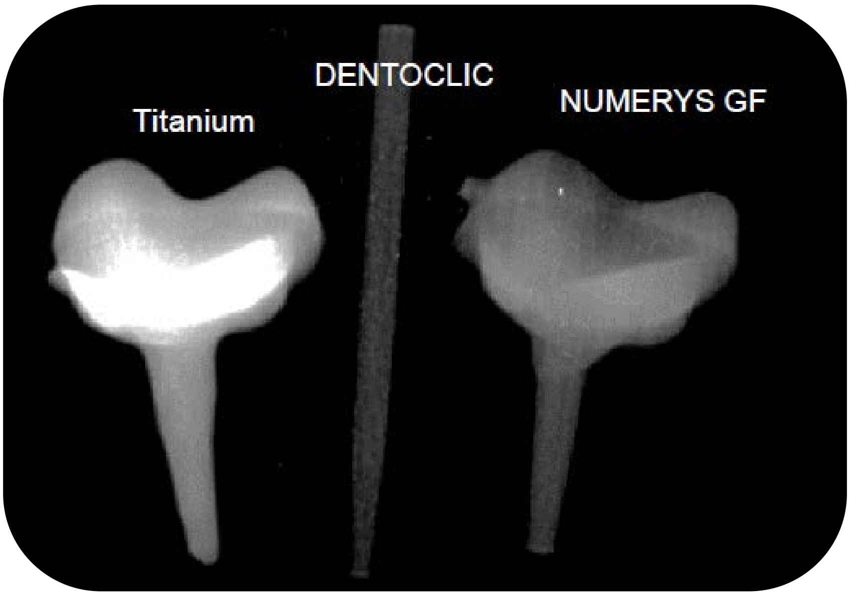


[27]

DISK SIZE	DISK NUMERYS GF
Middle Diam (mm)	94
Total Diam (mm)	**98,5**
Top H (mm)	5
Middle H (mm)	10
Bottom H (mm)	5
Total H (mm)	**20**

Radiopacity

Radiopacity of the post-and-core is important to the extent that it allows the prosthetic element to be clearly identified on an x-ray when surrounded by tooth, bone tissue and core material.

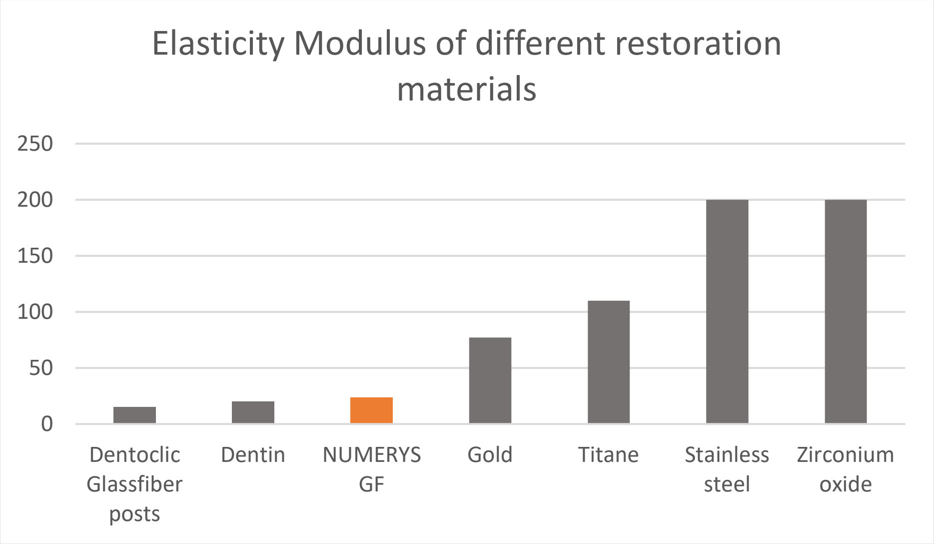


NUMERYS GF glass fibers are intrinsically radiopaque, giving the material a homogeneous radiopacity on all of its surface. [28]

Mechanical performances

A- ELASTICITY MODULUS

Elasticity has been reported to be an important predictor of intra-radicular material performance.



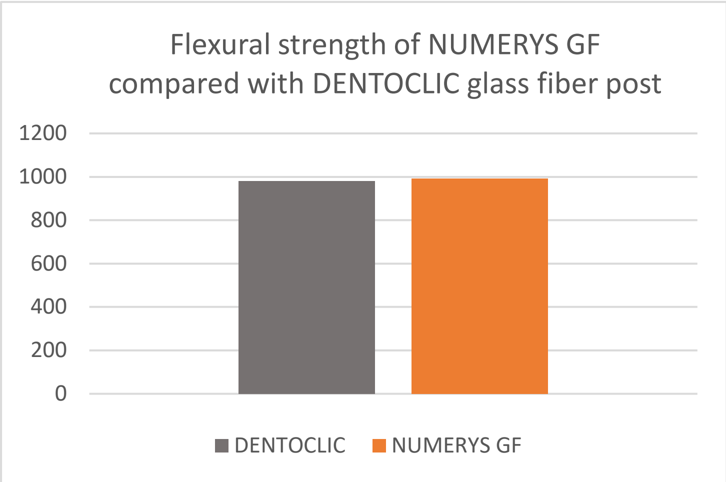
With high rigidity materials, the stress applied through the restored tooth is concentrated on the remaining tooth structure, increasing the risk of fracture. [29]

When materials with a similar elastic modulus to the dentin are used, the stresses are more uniformly distributed. [30-31]

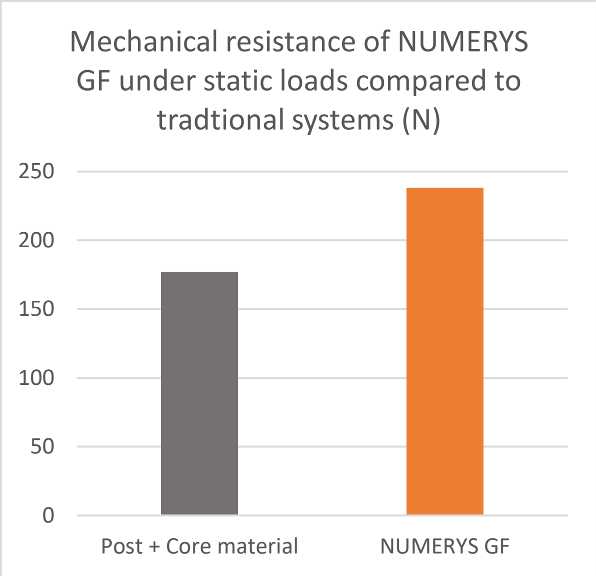
B- FLEXURAL STRENGTH

The flexural strength values obtained between DENTOCLIC and NUMERYS GF specimens are really close to each other: 980 MPa and 991 MPa respectively.

The graphical results show that both materials have a very similar mechanical behaviour. [32]
This is due to the resemblance between both materials' composition



C- BETTER MECHANICAL RESISTANCE – POST-AND-CORE



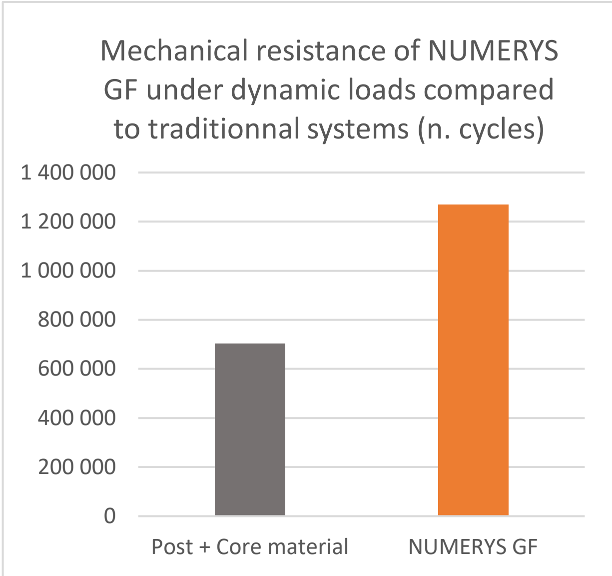
The results presented in the graph show that the maximum breakage point values obtained for NUMERYF GF post-and-cores are higher than for traditional post-and-cores (post + core build-up material).

This indicates that NUMERYF GF post-and-core systems possess higher resistance against mechanical constraints than traditionally used direct restoration glass fiber post-and-core systems. [32]

The results presented in the second graph show the number of load cycles tolerated by traditional post-and-core and NUMERYS GF post-and-core systems before breakage.

This simulates long-term masticatory constraints and thus resistance to fatigue of the material.

Those results mean that NUMERYS GF post-and-cores systems possess a higher resistance to mechanical fatigue than traditional glass fiber post-and-core systems. [32]



Digital Workflow

1- Scan

Select the material NUMERYS GF in the template order of the scanner platform software

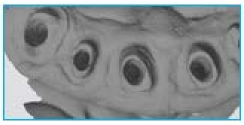
Scan the root as deep as possible or using a scan post (Dentoclic/Pivomatic) with an intra-oral scanner.

Store the scan file .stl

2- Computer Assisted Design

Export the scan file .stl

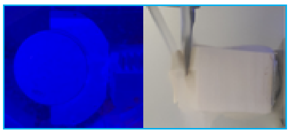
Select NUMERYS GF PC12/Disk parameters to design your dental prosthesis



Store the scan file .stl

3 - Manufacturing

- Position the NUMERYS GF block / disk in the milling equipment in accordance with the parameters defined by the manufacturer
- Export the design file .stl
- Machine the prosthesis using a diamond drill



4 – Post machining

- Remove the block from the equipment and make the final adjustment of the prosthesis

- Test the fitting of the post-and-core

NUMERYS GF can be used either for chairside application, directly in the professional office or exported to an exterior laboratory.

Clinical procedure

1- Canal preparation

- Etch the canal with phosphoric acid
- Rinse H20
- Dry with paper point
- Apply adhesive system (Dual-cure)
- Dry

2- Post-and-core preparation

- Check for anatomical fit Adjust if needed with a diamond bur
- Rinse Alcohol
- Dry
- Apply a layer of silane on the totality of the post-and-core
- Dry
- Apply adhesive system on the totality of the post-and-core
- Dry
- Light-cure 20 seconds
- Cement with a self-adhesive universal resin cement

3- Crown preparation

- Check for anatomical fit
- Prepare the prosthetic crown
- Cement with a self-adhesive universal resin cement

NUMERYS GF clinical procedure is based on the traditional clinical steps used for prefabricated glass fiber posts. Being composed of glass fiber, it is primordial to ensure the waterproofness of the system by following those clinical steps.

The prosthetic element is to be prepared following the same critical steps than glass fiber prefabricated elements: silane application and adhesive bonding. Indeed, silane as a coupling agent have shown to enhance the bond strength between the glass fiber posts and resin cements. [33-34-35]

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