History
In 1995 Torabinejad introduced to the market the substance MTA (Mineral Trioxide Aggregate). It is modified Portland cement.

In the past material was available only as a grey type of the MTA. For the esthetical reason, after a several years of scientific researches the white type of the MTA has been introduced with the shorter setting time, decreased up to 90% of iron, aluminium and magnesium oxides, a smaller diameter of particles and a higher pH value.

2012 was the turning point in the history of these products. After 5 years of scientific research and clinical tests, the Company CERKAMED is ready to finalize the production technology and launch innovative MTA+ on the dental market.

What MTA is and what it does?
MTA+ is the material for rebuilding root canals.

Composition of MTA
The MTA cement has composition similar to Portland cement, which has been enriched with bismuth oxides, does not consists heavy particles of metals and the particles of improved MTA have a smaller diameter than other similar cements:

- potassium oxides
- aluminium oxides
- ferric oxides
- potassium sulphate
- sodium sulphate

Advantages of MTA cements:

- high biocompatibility
- Low micro-leakage
- high mechanical strength
- acts antibacterial and anti fungicidal
- is bioactive, enhances formation of mineralized tissues
- visible on an X-ray image
- MTA is less toxic than amalgam
- MTA’s hermetic is better than amalgam
- MTA-effectively inducing formation of periadicular cementum
- ongoing scientific studies and clinical researches confirmed formation of thick and uniformed structure of the periadicular tissues after using MTA, direct application on the pulp tissue does not cause damaging or inflammation, which might happened when calcium hydroxide is placed.

Advantages of MTA cements:
Antibacterial and fungicidal properties of MTA

The MTA cements have antibacterial and fungicidal properties (because of high pH) in relation to following types:

- *Enterococcus faecalis*
- *Streptococcus sanguis*
- *Staphylococcus epidermis*
- *Micrococcus luteus*
- *Pseudomonas aeruginosa*
- *Escherichia coli*
- *Candida albicans*

Interactions

Possible interactions might occur when MTA cement is combined with other materials during the endodontic treatment:

- Chlorhexidine digluconate (CHX) – might cause difficulties for correct setting,
- Sodium hypochlorite (NaOCl) – might cause a shorter time of setting,
- Saline (NaCl) – might cause a longer time of setting,
- Lignocaine might cause a longer time of setting.

Setting time of MTA cement

Setting time of MTA cement is about 3 h (165 min +/- 5 min).

<table>
<thead>
<tr>
<th>After mixing</th>
<th>Powder</th>
<th>Liquid</th>
<th>Colloidal gel</th>
</tr>
</thead>
</table>

1g powder to 0.33g water = 3:1 proportions powder/water

Directly after mixing with water pH 10.2 after 3 hours pH 12.5

Excessive volume of water cause higher level of solubility which increase remineralisation (this is caused by higher concentration of calcium hydroxide formed ions).

Maximum strength of the MTA is achieved after 3-4 weeks (44.2 MPa).

Setting time of MTA+ cement

It is the only one characterized by nanoparticles. MTA+ Cerkamed has the lowest level of the heat of hydration.

As a result of the technology developed by CERKAMED, the MTA+ particle is three times smaller than the smallest particles of material produced by other manufacturers.

Why MTA+ is innovative?

It is the only one characterized by nanoparticles. MTA+ Cerkamed has the lowest level of the heat of hydration.

Why the smaller grain is better?

- facilitates penetration of calcium ions to the demineralized tissue
- facilitates packing material in the application site
- facilitates preparation
- increases sealing process
- increases strength
- homogeneity and phasing of the material reduces setting time

Pictures of MTA grains taken with scanning microscope at Department of Materials Science and Ceramics, AGH University of Science and Technology

Pic. 1. MTA+ Cerkamed. Nanoparticles with similar size and compact weight. Uniform structure facilitates preparation, application of the material and sealing.

Pic 2., Pic 3. Pictures of other MTA leaders on the market. Pictures of other MTA leaders on the market. Particles with varied size forming agglomerates. Lack of uniform structure hinder the preparation and accurate application and decreases the sealing process of the filling.
The value of the hydration heat, generated during binding cement with water, affects the accumulation of the heat in the early stages of hardening, which may cause the difference in the stresses and reduces the strength of the set material.

The determination of the hydration heat was held in BMR calorimeter (ICNf PAN) on 3 specimens, in a temperature of 25°C, at Department of Materials Science and Ceramics, AGH University of Science and Technology.

MTA+ Cerkamed has the lowest degree of hydration heat.

According with ISO 3107 standard, the crushing strength of peridentines shall maintain at least the level 35 Mpa. Mechanical strength tests showed that the value of the crushing strength of MTA+ Cerkamed is 10% higher than the crushing strength of other materials.

Research results

<table>
<thead>
<tr>
<th>Sample no</th>
<th>Sample marking</th>
<th>h0</th>
<th>F max</th>
<th>F destruction</th>
<th>h0 deformation at the destruction moment</th>
<th>d0</th>
<th>s0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MTA+ Cerkamed</td>
<td>5.95</td>
<td>62</td>
<td>41.7</td>
<td>0.9</td>
<td>4.2</td>
<td>5.95</td>
</tr>
<tr>
<td>2</td>
<td>Competitive product A</td>
<td>6.1</td>
<td>61.5</td>
<td>40.5</td>
<td>3.5</td>
<td>4.15</td>
<td>6.1</td>
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<tr>
<td>3</td>
<td>Competitive product B</td>
<td>5.85</td>
<td>50</td>
<td>36.7</td>
<td>0.6</td>
<td>4.12</td>
<td>5.85</td>
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<tr>
<td>4</td>
<td>Competitive product C</td>
<td>6</td>
<td>61</td>
<td>28.3</td>
<td>0.4</td>
<td>4</td>
<td>6.1</td>
</tr>
</tbody>
</table>

MTA+ Cerkamed has the lowest level of the heat of hydration.

Perfectly elaborated composition MTA+

Thanks to the high content of calcium ions, MTA+ Cerkamed has remineralizing and bacteriostatic properties. Silicon-calcium compounds contained in the product help to rebuild tissues after perforation and intracanal resorption. Bismuth oxide content results in perfect visibility on the images, and absorption of X-ray radiation by MTA+ Cerkamed is better than it is for other materials. High PH value of MTA+ Cerkamed give an antibacterial effects from the moment it is applied.

The diagram above shows that for the complete duration of time that the material is binding, PH remains on the high level so material MTA+ Cerkamed has the highest PH. From the moment of application its value increases to the level of 12.61, and then lowers to a stable level of 12.54.
Practical advice

Applied MTA should be covered by a damp pellet of cotton because correct setting moisture is required. Then the tooth should be capped with a hermetic dressing for 1-2 days. CAUTION!!! Do not use MTA in case of severe infection – acidity pH unable setting MTA!

Working with the material is much easier when using proper auxiliary instruments.

Block MATRIX MTA+

Block Matrix MTA+ is designed to form a portion of prepared MTA to place it in the fraction of the tooth or the root canal. All walls of the MTA+ matrix have mould with the description of diameter from 0.7 to 1.0mm. Place prepared material in the chosen wall mould to form the required diameter. Use proper sterile instrument for handling formed material from the mould.

Instruments for handling and application

Instruments made of stainless steel resistant to corrosion, withstand for tension (bending, pressing), consistence of C (compounds of carbon) min 0.15%.

Set of instruments with two handles and four tips.

Applicator for MTA+

Reusable dental tools for handling and application of prepared measure of MTA+ material. Instruments made of stainless steel resistant to corrosion.

Device include: handle and piston.

The piston is used to squeeze the content to the treatment area.

In order to use the product, insert the piston into the corresponding handle, then pull back the piston about 1 cm. Put the previously prepared MTA+ material on the glass plate and thrust the measurement of the preparation into the carrier tip. Place the tip of the applicator directly into the area intended, and then plunger to apply the material.
Besides the functional and biological properties, MTA+ Cerkamed preparation is a breakthrough in the availability of high-quality materials for endodontics. It is contributed to the dissemination and wider use of endodontic microsurgery procedures, due to its price, which is two- or three-times lower than other MTA preparations available on the market.

Balance between quality and price of comparable products.

From today available in every dentist office!

MTA+ by Cerkamed

Handling the product

Place on the mixing plate the content of MTA+ powder from the glass vial. Add 1-2 drops of MTA+ liquid using the pipette. Mix within 30 sec until consistency of the wet sand is achieved. If the consistency of the mixture is too dense or crumbly then add another drop of the liquid (or distilled water). Insert the preparation into selected field by means of the carrier.

Use the preparation only when sharp symptoms are gone as the acid pH interferes with the setting process of MTA+. Contact with moisture, as well with the blood accelerates binding of the preparation.

MTA+ powder is a dose for single use. When mixed with MTA+ liquid (or distilled water), it should be used within 10 minutes. After that time the product is not suitable for use due to the progressive setting process and hardening of the mixture. Use the package of MTA+ liquid within 12 months after first opening.
**REPAIR PERFORATION CAUSED BY A COMPLICATION OF INTERNAL RESORPTION:**

1. Clean and shape the root canal using endodontic instruments and rinse with sodium hypochlorite (pic.1,2).
2. Close the tooth chamber by using temporary filling paste—calcium hydroxide (pic.3).
3. During the next appointment, after 1–2 weeks, calcium hydroxide has to be removed from the root canal and rinse by sodium hypochlorite (pic.4).
4. Dry the root canal with paper points and locate the resorption point (pic.5).
5. Fill the root canal up to the point of resorption (pic.6).
6. Prepared MTA according the instruction and place at the exact point of resorption (pic.7).
7. An x-ray is required to confirm the right placement of MTA. In case of not sufficient coverage of defect, the whole MTA material has to be rinsed and repeat the procedure once again.
8. A damp cotton pellet has to be placed in the root canal (pic.9), and all the fractured area has to be covered and sealed by temporary root filling material for at least 3,2 hours (pic.10).
9. After this time or during next visit the bonding of MTA has to be checked. The material should be hard. If this not happened, rinse the old material and repeat the procedure once again.
10. If MTA has set hard, fill the rest of the root canal. The MTA remains in place as a part of root canal filling (pic.11).

**INTERNAL REPAIR OF (AN IATROGENIC) PERFORATION:**

1. Clean and shape the root canal using endodontic instruments (pic.1) and rinse with sodium hypochlorite (pic.2).
2. Use the paper points to dry the root canal (pic.3), separate the perforation.
3. Fill the root canal up to point of perforation (pic.4).
4. Prepare MTA according to instruction; place it at the exact point of perforation (pic.5). MTA has to be precisely condensed by using a small condenser instrument, or paper points (pic.6).
5. An X-ray is required to confirm the right placement of MTA. If the coverage is not correct, the whole MTA has to be rinsed and repeat the procedure once again.
6. A damp cotton pellet place in the root canal (pic.7) and whole fractured area has to be capped by a temporary filling material for at least 3,2 hours (pic.8).
7. After this time or during next visit the MTA bonding has to be checked. The material structure should be hard, if this is not happened, rinse it out entirely and repeat the procedure.
8. If MTA has set hard, fill the rest of the root canal. MTA remains in place as a part of root canal filling (pic.9).
APEXIFICATION:

1. Clean and shape the root canal using endodontic instruments (pic.1) and rinse with sodium hypochlorite (pic.2).
2. Use paper points to dry the root canal (pic.3), then insert a prepared paste of calcium hydroxide (CALCIPAST) and leave it there for 1-2 weeks (pic.4). Close the procedure with a temporary filling.
3. During the next visit remove calcium-hydroxide and rinse with sodium hypochlorite2% (CHLORAX2%) (pic.5).
4. Prepare MTA according the instruction, place in the apical area and compact it using instruments (pic.6) or paper points (pic.7). MTA should create the barrier filling of root canal on the length from 3 to 5 mm.
5. An X-ray is required to confirm the position of MTA. If the coverage is not sufficient the whole material has to be rinsed out and repeat the procedure.
6. A damp cotton pellet is inserted into the root canal (pic.8), close the procedure with a temporary filling for at least 3,2 hours (pic.9).
7. After this time or during the next visit check the MTA bonding, the structure should be hard, and if it is not happened the whole material has to be rinsed out and repeat the procedure.
8. If MTA has set hard, fill the rest of root canal (pic.10), the MTA remains in place as a permanent part of the root canal filling.

RETROGRADE ROOT CANAL FILLING

1. Prepare a good access to the apex and make the root tip resection using a surgical bur (pic.1).
2. Separate the area. Use the paper points to dry the resected tip of the tooth (pic.2). Use the haemostatic material to stop the bleeding (pic.3).
3. Prepare MTA according the instruction and place it in the top of the root canal apex, using a small condenser (pic.4).
4. Remove an excess of the material and clean the surface of root with damp gauze (pic.5).
5. An X-ray is required to confirm the position of MTA, which remains in place as a permanent part of the root canal filling (pic.6).
A DIRECT PULP CAPPING, A PARTIAL REMOVAL OF THE TOOTH PULP:

1. Clean and shape the edges of fractured area, remove all infected by carries tissue (pic.1).
2. Rinse the fracture area and the uncovered tooth pulp with sodium hypochlorite (CHLORAXID 2% or 5.25%) (pic.2).
3. Stop bleeding with the haemostatic material (pic.3).
4. Mix MTA according the instruction, place a small quantity prepared MTA on open pulp tissue (pic.4).
5. Remove an excess of moisture with the damp swab (pic.5).
6. Cover MTA by the glass ionomer cement and follow the instruction of polymerisation process (pic.6).
7. Etch the walls of the fracture with the orthophosphoric acid (BLUE ETOH) (pic.7), then rinse.
8. Dry gently, leave it damp but not wet (pic.8), cover by a composite material and finish restoration (pic.9).

Check the pulp during next visit, its condition should be controlled radiologically, from 3 to 6 months or when it is necessary.