New abrasive tools fixed by hybrid binder on base of inorganic polymers

The project FR-TI2/390/TIP

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Classic abrasives tools

Matrix:

- Ceramic bonds:
  - Advantages: high mechanical strengths
  - Disadvantages: high manufacturing costs (firing - 1250°C, 10 hours)
- Epoxy resin bonds:
  - Advantages: lower manufacturing costs, quickly production
  - Disadvantages: low mechanical strengths under higher temperature, risk of firing and dangerous gases during grinding

Abrasive grains:

- Corundum (brown, white), silicon carbide, diamond powder, etc.

Abrasive tools fixed by geopolymers

Matrix:

- Mixture of industrially prepared clay material and blast furnace slag (1 : 1.8) with potassium silicate solution – too hard and compact matrix
- Softer matrix – addition of slate clay

Abrasive grains:

- Yes: Corundum (brown, white), waste garnet from glass sandblasting (content of glass powder), diamond powder
- No: Silicon carbide (metallic silicon - bubbles), washed silicon carbide (still content of metallic silicon), recycled silicon carbide (lack of material)

Application

- Semi-industrial grinding and polishing of stones
- Metal cutting by grinding wheel
- Metal cutting by lathe grinding
- Hand grinding stones

Semi-industrial grinding and polishing of stones

- Abrasives: brown corundum F36 (26 – 35 wt.%)
- Slate clay (5 wt. %)
- Addition of grinded stone - 28 wt. % (limestone, granite, marble, etc.)

Grinding/polishing machine – general view

Grinding stones fixed in holder

Detailed view on grinding stones after grinding

Metal cutting by grinding wheel

- Use of grinding machine
- Speed: 2800 revolutions per minute
- Time of grinding : 3 minutes
- Water cooling

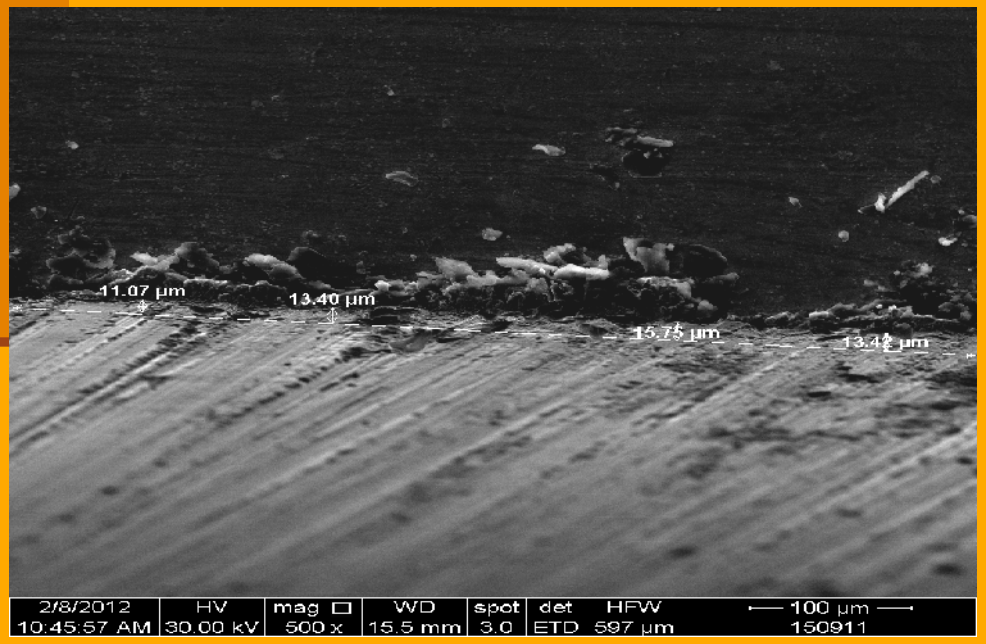
- Wheel with diameters 30 cm
- Abrasive grains: corundum (brown, white)
- Different content of abrasives
- Various particle size

- Placement of wheel after dressing
- Hard metal bar

Overall arrangement

Results

- Matrix from industrially prepared clay material and blast furnace slag – too hard and compact matrix
- Addition of slate clay – maximum 9.5 wt. %
- Higher content of slate clay – low strengths, loss of compactness



brown corundum F80 (76 wt. %)

Material with 14 wt. % of slate clay

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Metal cutting by lathe grinding

- Universal centre lathe
- Speed: 224 revolutions per minute
- Time: 2 minutes
- Iron pipe - untreated
- Water cooling
- Clay-slag matrix
- Samples: 2.5 x 10 x 1 cm
- Abrasive grains: corundum (brown, white)
- Different content of abrasives
- Various particle size

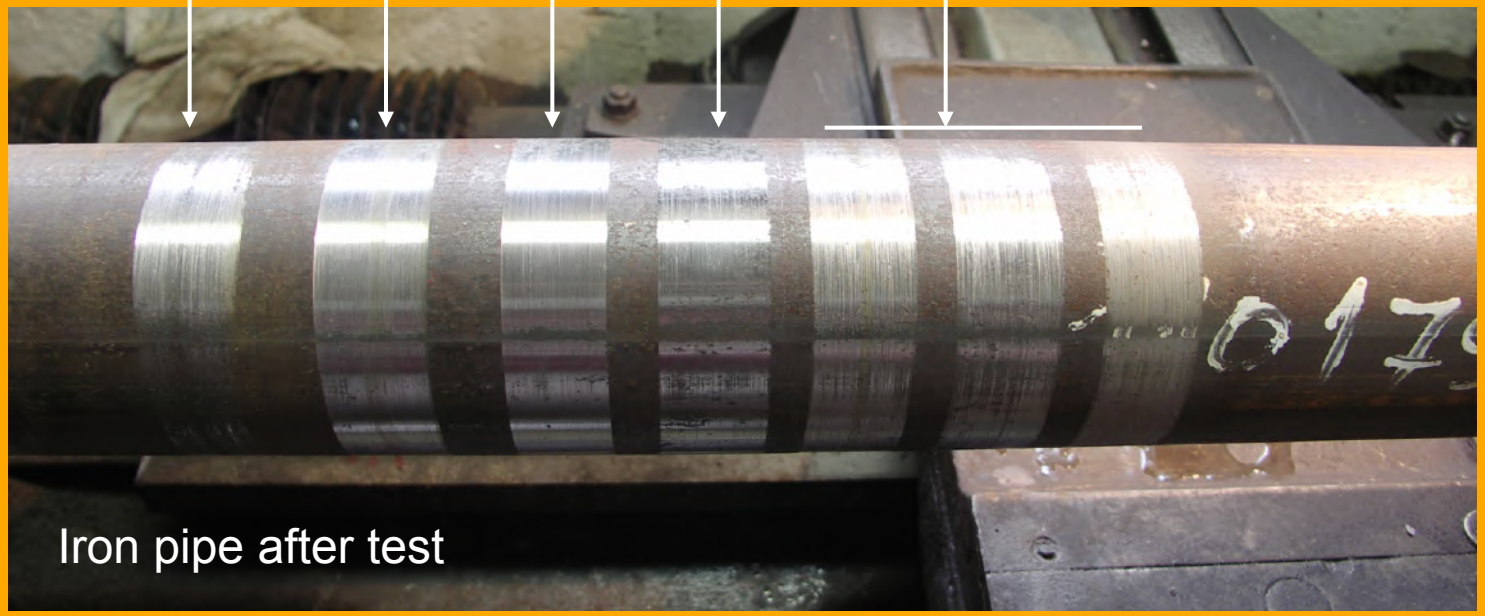
Universal centre lathe

Clamping of grinder in tailstock

Overall arrangement

Various particle size of abrasive grains

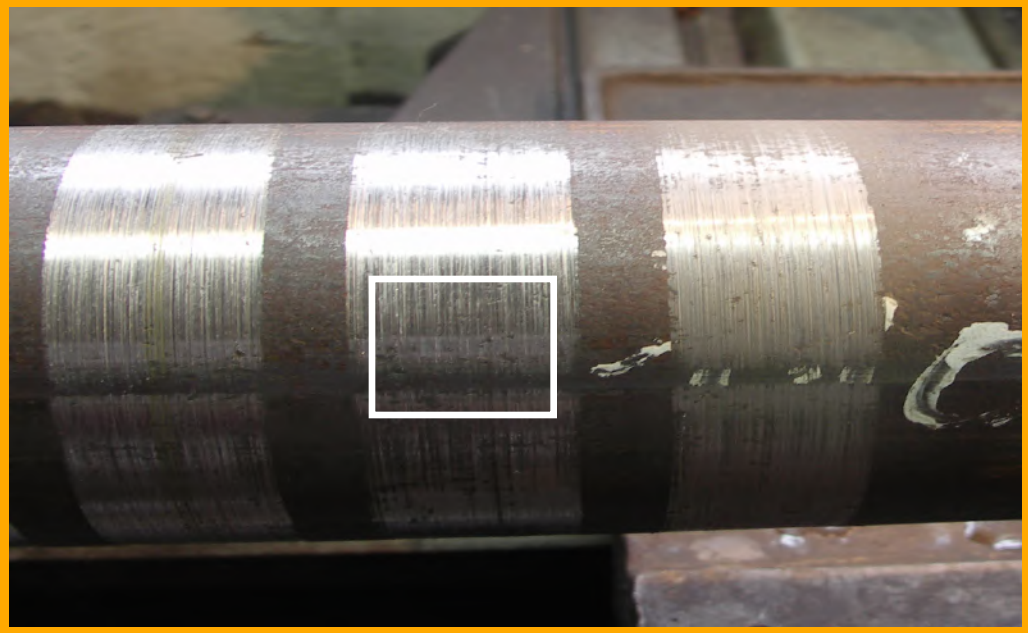
- **F36, F100, F240, F500, F36** (different content of abrasives)



- Different particle size of grains – different abrasive marks
- The best way – use the big grains at the beginning and fine grains for finishing

Different content of abrasives

- Abrasive grains: brown corundum F36

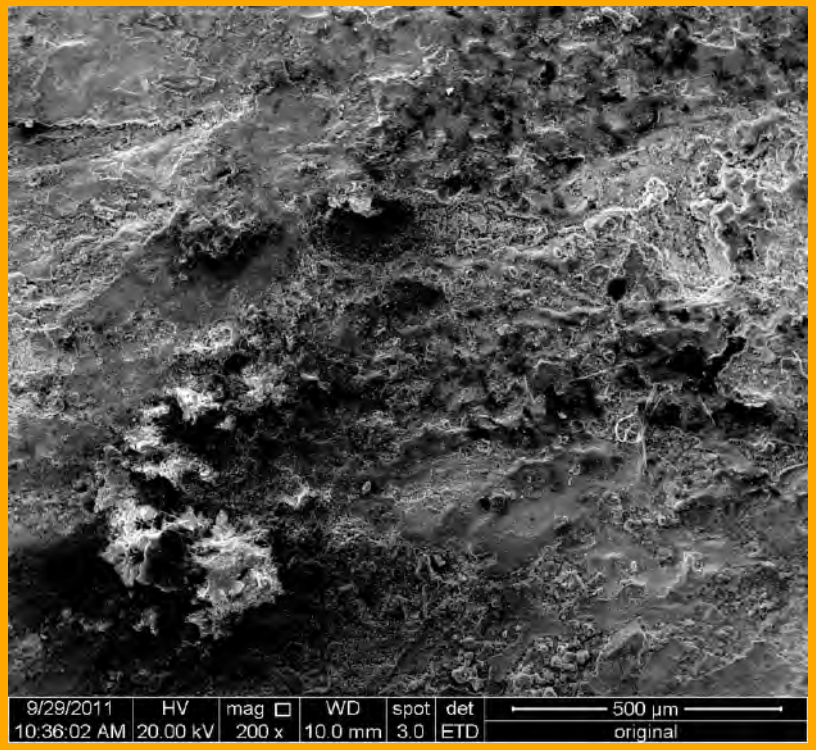


42 % 35 % 26 %

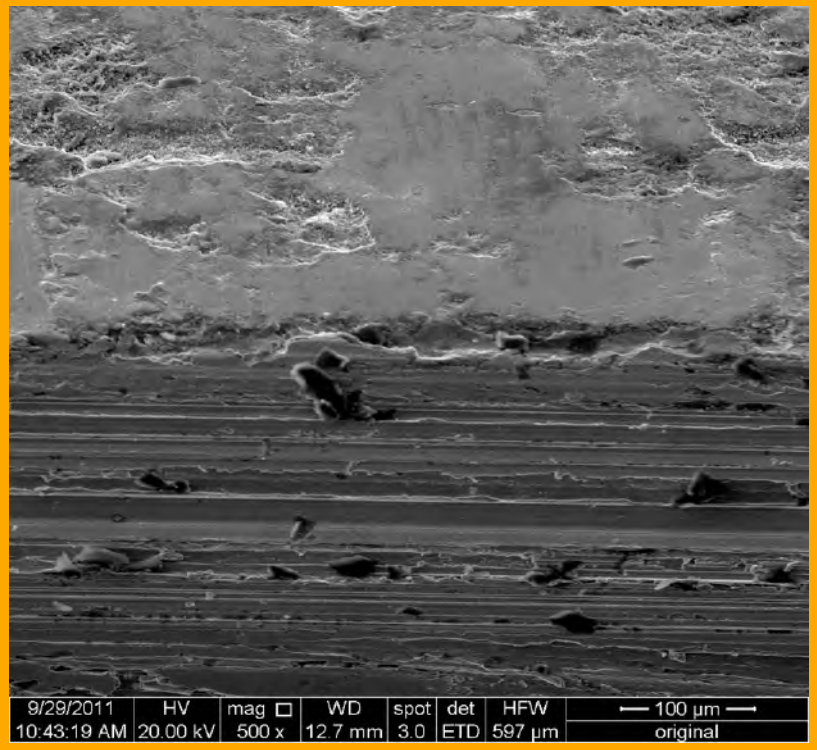
Preparation for SEM – cutting of samples (1.0 x 1.0 cm)

Original material before grinding

Scanning Electron Microscopy



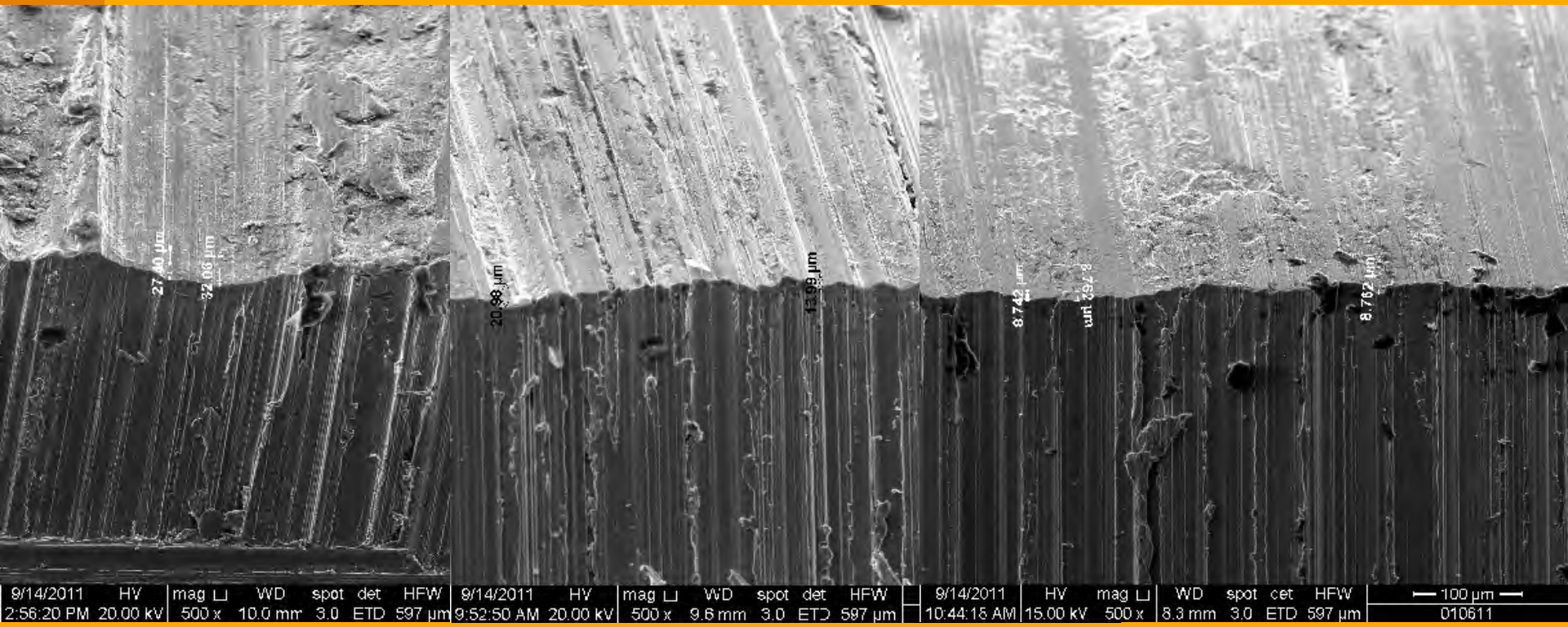
Plan view on the surface



Auxiliary view

Materials after grinding (SEM)

Magnitude 500x



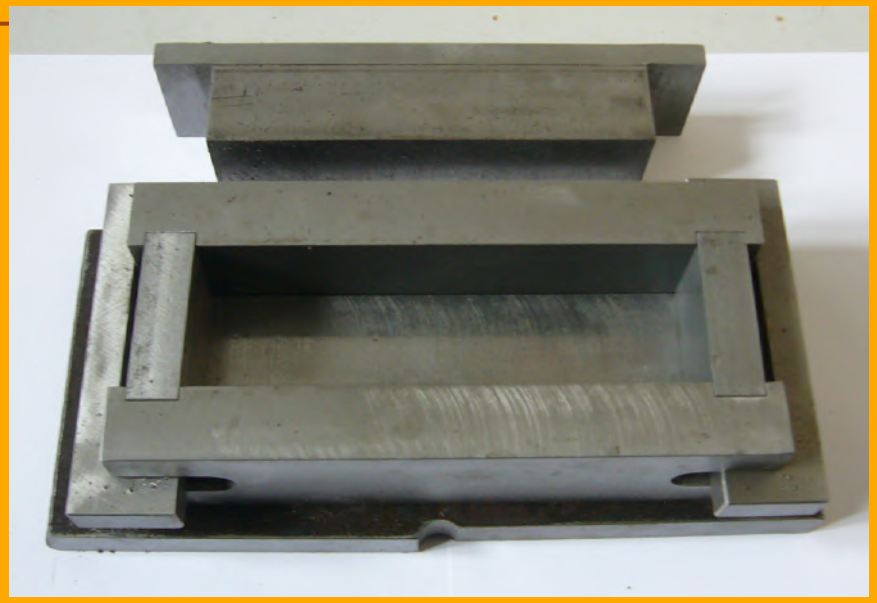
brown corundum F36
marks: 27.4 – 32 µm

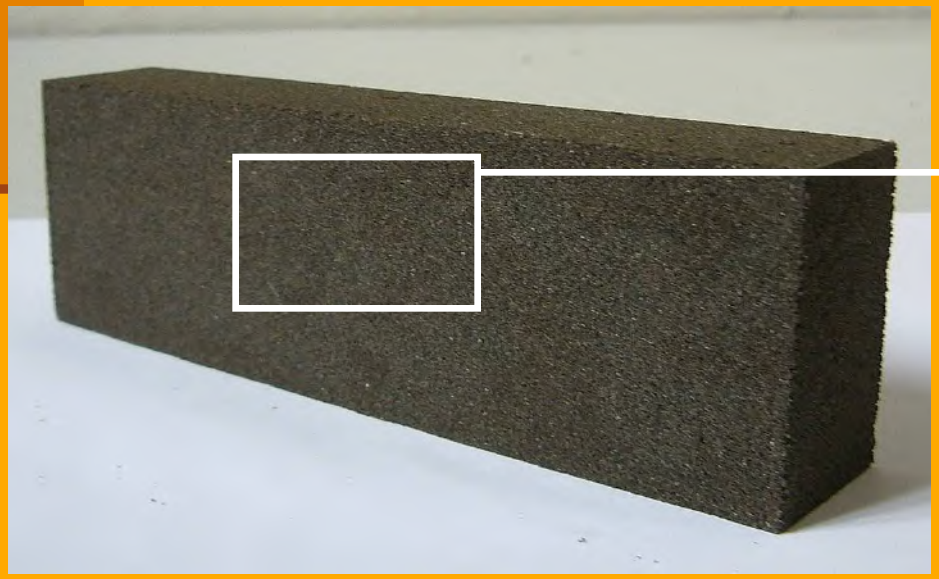
brown corundum F100
marks: 13 – 20.9 µm

white corundum F500
marks: 8.74 - 8.76 µm

Hand grinder – mould pressing

- Metal multi-piece mold
- Prism 5 x 15 x 2.5 cm
- Clay-slag matrix
- Abrasives: brown corundum (content 75 – 80%)
- Water content: 6.5 % – 7.0 %
- Pressing power: 20 MPa





Conclusion

- Well matured geopolymer matrix in combination with uniform distributed abrasive grains creates an effective grinder.
- During grinding the matrix gives off the blunt grains and replaces them by new ones.
- Hardness of matrix coul be adapted according to specific purposes (for example: high strengths for grinding wheel, lower strengths for hand grinding)
- Sort, content and particle size of additives depends:
  1) The way of preparation: mould casting or pressing, vibro-compacting, etc.
  2) The way of grinding: hand grinding, different grinding machines
  3) The way of utilization: stone or metal grinding, super finishing, etc.
- Next plans:
  - Certificated tests of grinding quality
  - Semi-industrial production (cooperation with CDA)

Thank you for your attention

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