



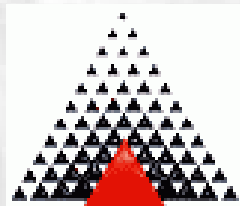
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Surface pretreatment – a way to effective utilization of waste plastics as concrete aggregate. Review and first experiences

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Electronic waste (WEEE)

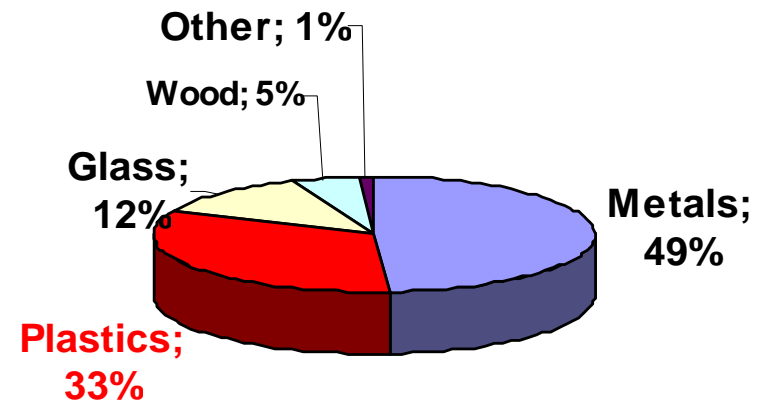
- the serious problem of the future



1 consumer in EU creates
appr. **16 kg** of WEEE per year



Typical composition of WEEE





LWA – energy pretentious production

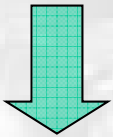
Consumption growth

Environmentally friendly alternate aggregates



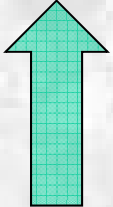
Consumption growth, life-cycle shortening

New kinds of lightweight concretes

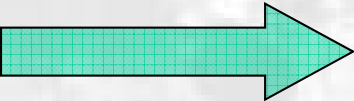


WEEE
Production growth

Exploitation of waste plastics

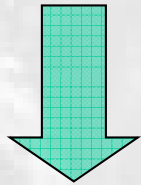


building sector

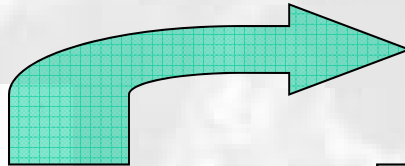


Recycling necessity

RECYCLING of EEE



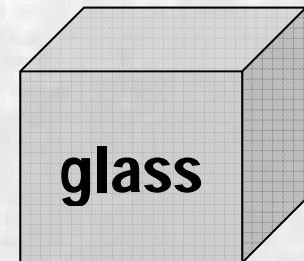
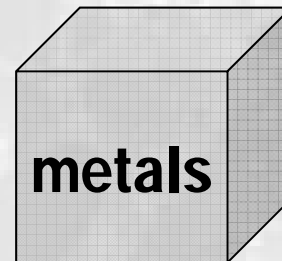
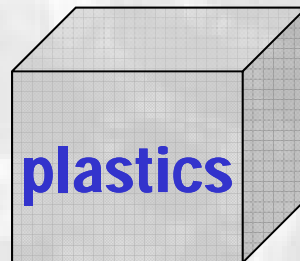
crushing



Dry separation of components from crushed waste



magnetical, vibrational or air flow method



Plastic shred - material with unknown properties

Mixture of plastics with
different density
(according to WEEE source)

Diversity of grains form



Presence of ineligible
materials



Portion of metals $\approx 0,5\%$



Wettability of plastic surface by cement paste

1. **Effectiveness** of aggregate in the cement composite depends on the quality of **the bond** between aggregate surface and cement matrix
2. **Good bond** between aggregate surface and cement matrix depends on **the wettability** of aggregate material by water
3. **Good wettability** means that contact angle between aggregate and water need to be the least.

Water drop on the top of printer case



Basic parameters and treatments details of plastic aggregates

Property	Unit	Value	Notes
Density over 1000 kg/m ³	% wt.	77	Mixture of PS, ABS, EP PE
Density below 1000 kg/m ³	% wt.	23	
Metal contaminants	% wt.	0.52	
Apparent bulk density	kg/m ³	540	STN 721171 part C
Particle density (average)	kg/m ³	1016	STN 721171 part B
Voids ratio	% vol.	47	STN 721171 part E
pH of water extract	---	7.84	7,33 – value for tap water
Conductivity of water extract	μS/cm	440	406 – value for tap water

PS – polystyrene, ABS – acrylonitril-butadien-styrene, EP - epoxy resin, PE - polyethylene

Mixture	Primary treating liquid	Post-treating solid
Ref	None	None
Hf	Silicone hydrophobizing agent	None
Wg	Water glass	None
Coat1	Acrylate paint	None
Coat2	Silicate (mineral) paint	None
Wg1	Water glass	Blast furnace slag
Wg2	Water glass	Quartz sand
Cem	Cement paste	None

Basic surface characteristics of treated PA



Untreated plastic granules



Plastic grains treated with cement

Mix	Surface texture	Surface property	Wetting
Ref	Hard, glassy, nonporous	Rather hydrophobic	Weak
Hf	Hard, glassy, nonporous	Hydrophobic	None
Wg	Hard, fineporous	Rather hydrophilic	Well
Coat1	Soft, mat	Rather hydrophobic	Weak
Coat2	Hard, rough due to filler	Rather hydrophobic	Better
Wg1	Hard, rough, fineporous	Rather hydrophilic	Well
Wg2	Hard, rough, fineporous	Rather hydrophilic	Well
Cem	Hard, porous	Hydrophilic	Best

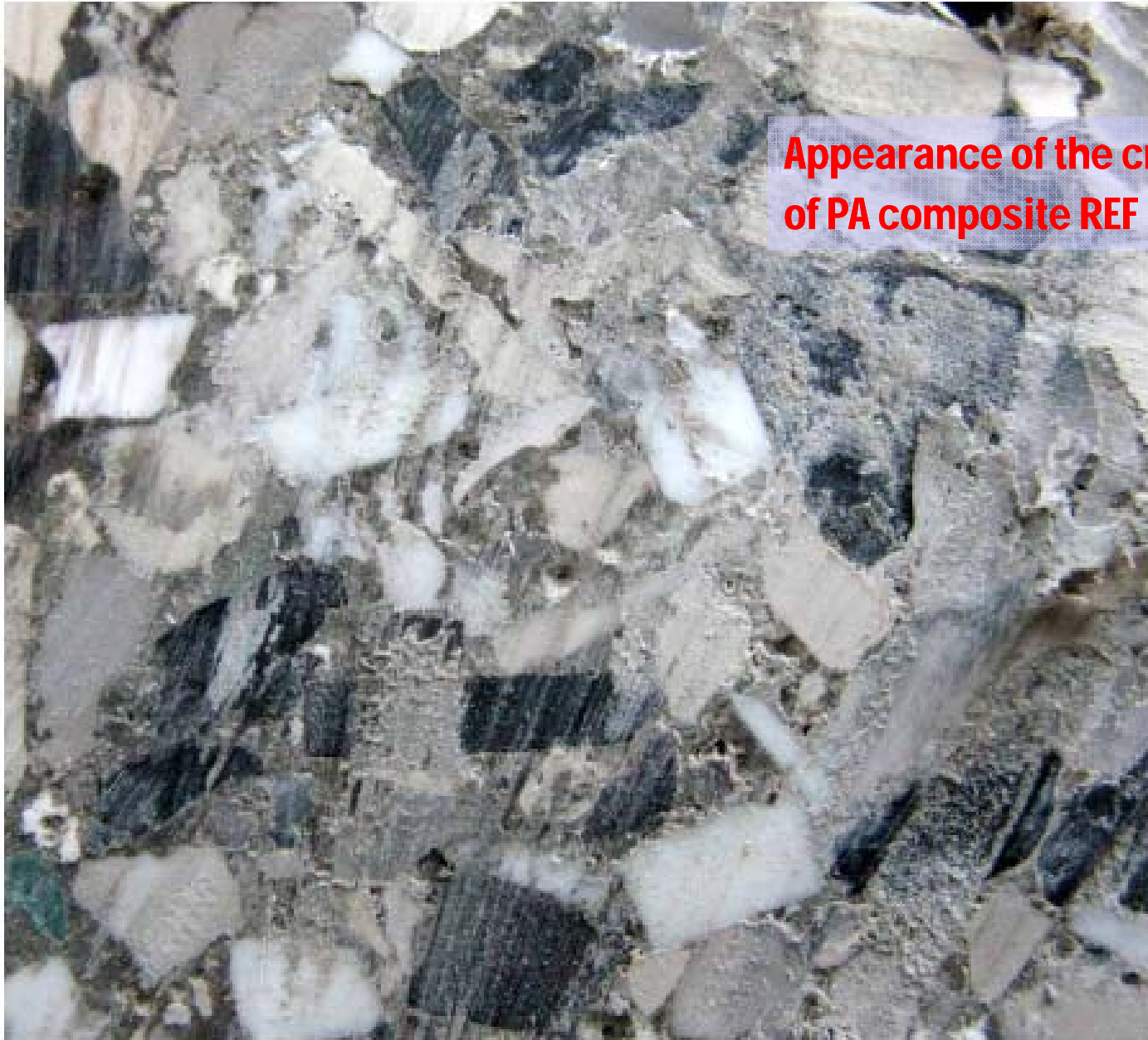


Wg – composite and treated PA



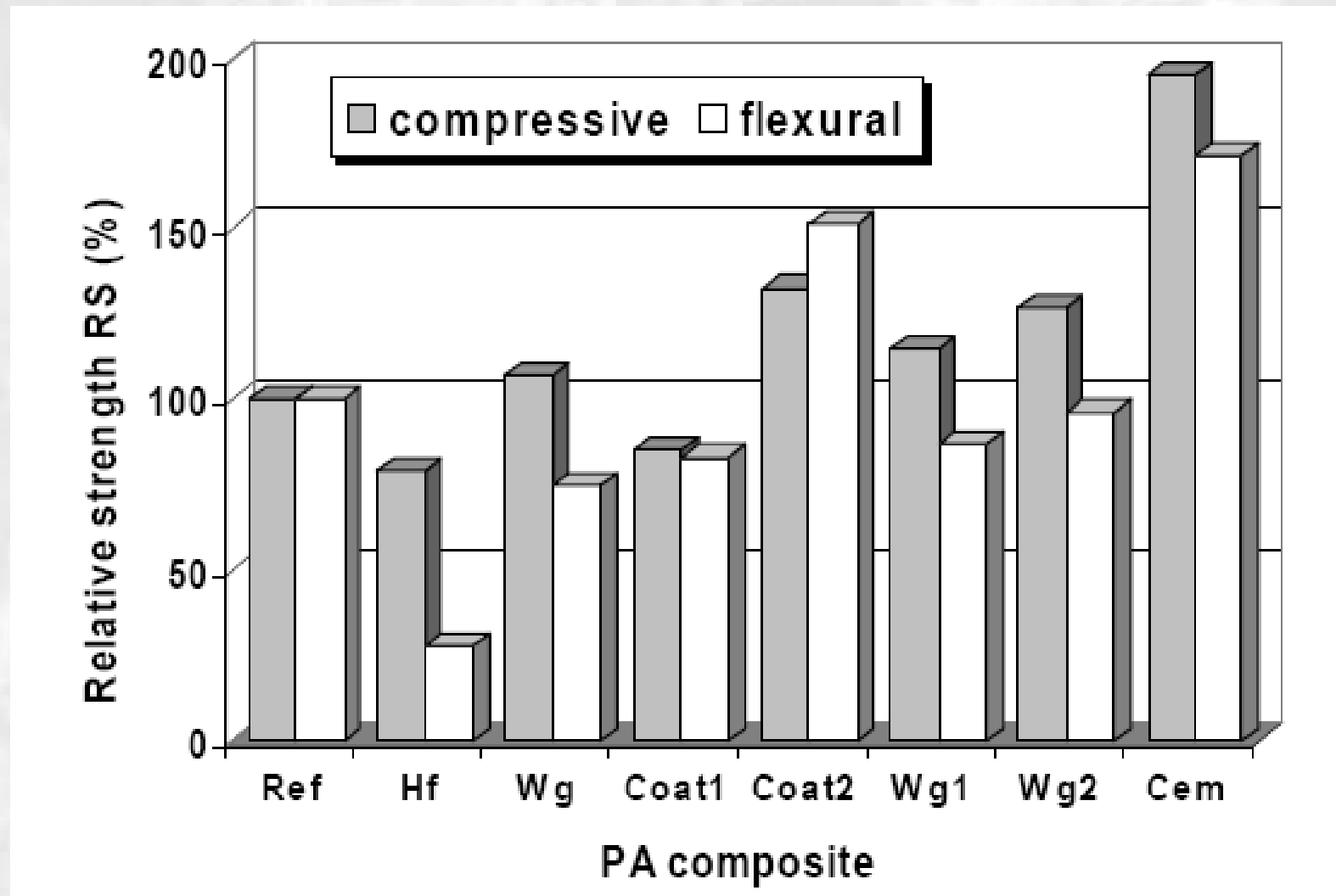
Cem – treated PA and composite



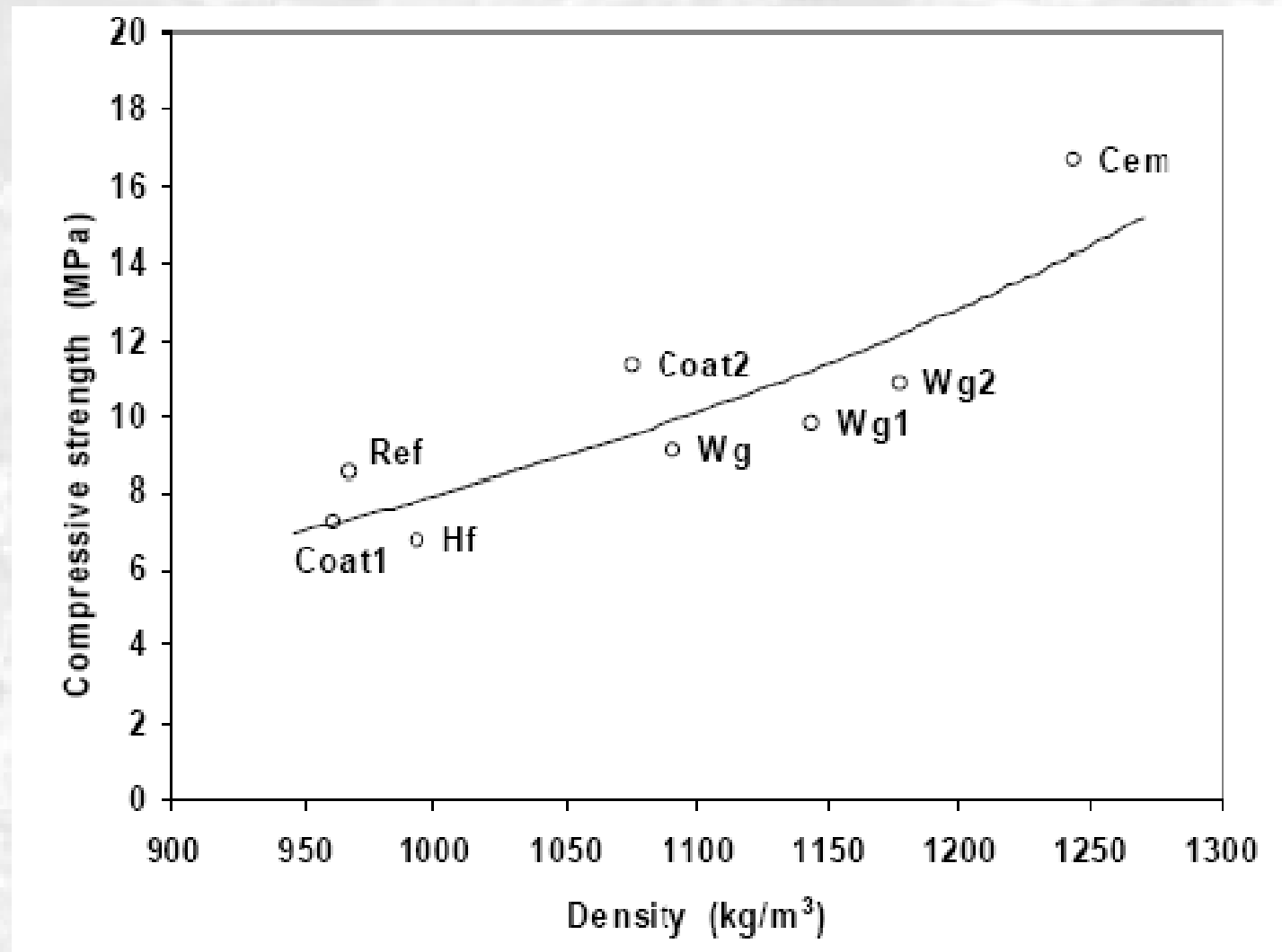


**Appearance of the cross section
of PA composite REF**

Effect of PA treatment on strength of PA composite



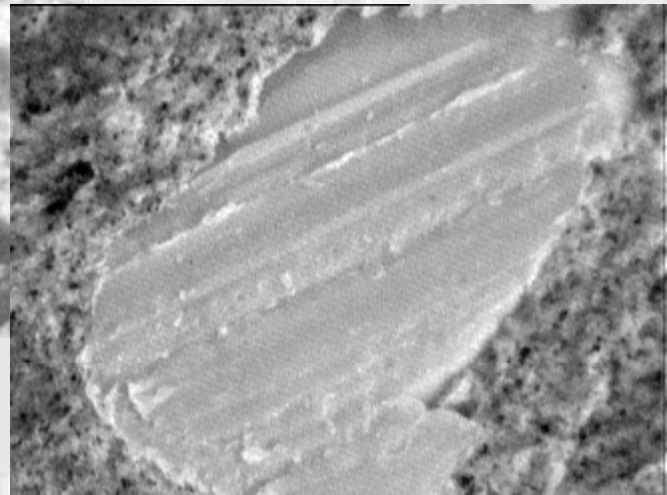
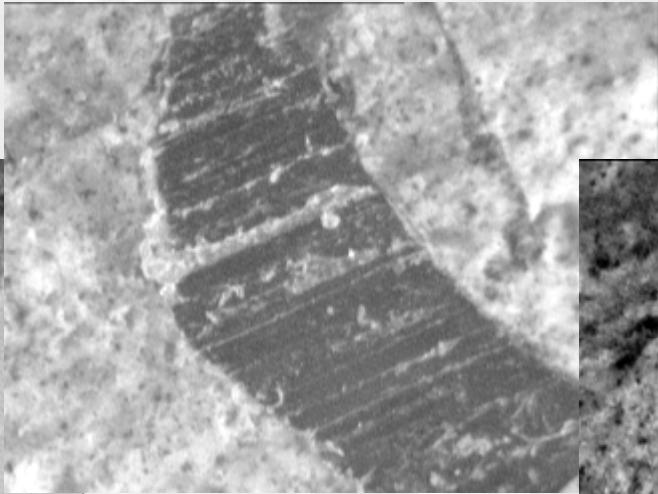
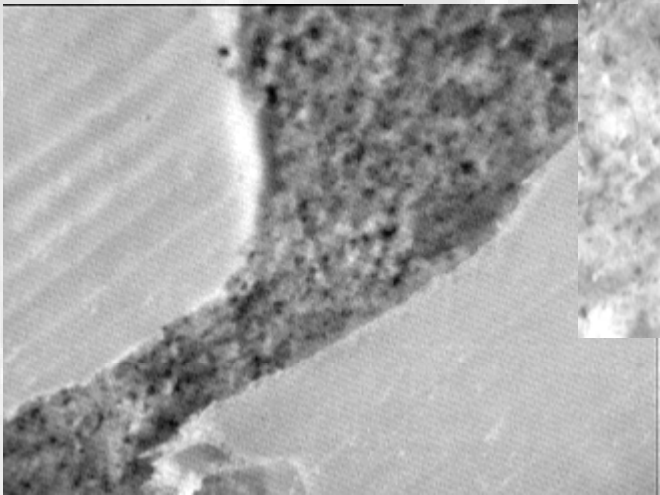
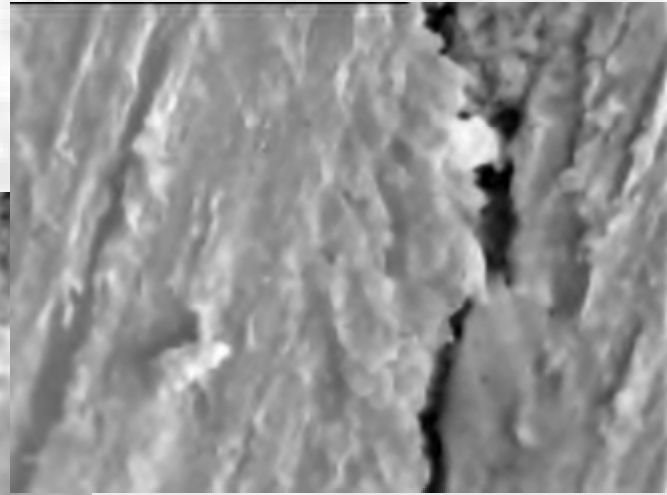
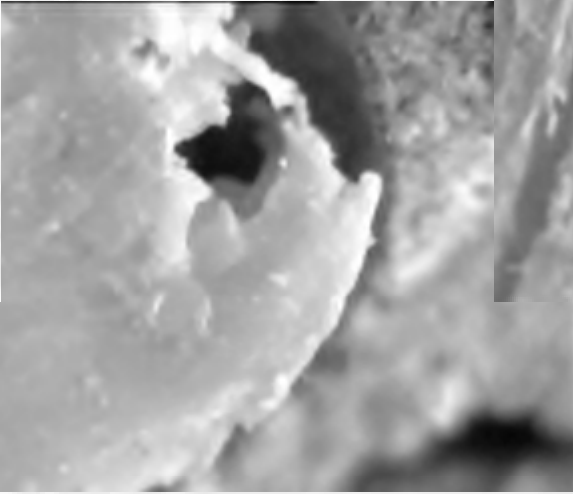
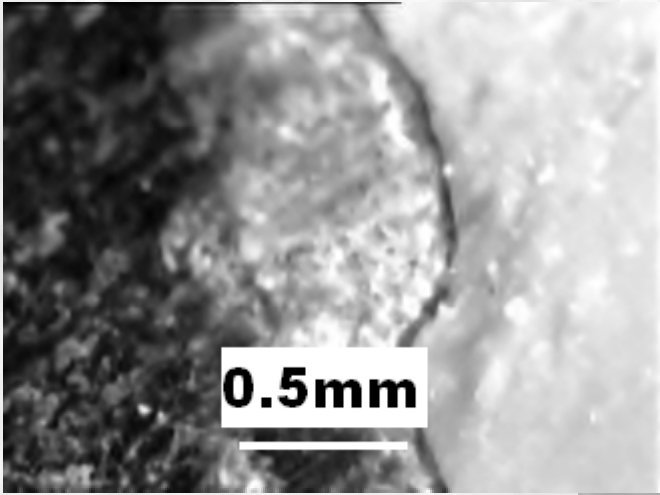
Relation between the **density** and **compressive strength** of the PA composites



Sample Ref

0.5mm

Sample Cem



Conclusions

- **Flexural strength** – the most effective treatment of PA is coating on the water glass base (Coat2) and covering with cement slurry (Cem)
- **Compressive strength** – the most effective treatments of PA are Coat2, Cem as well as Wg, Wg1 and Wg2
- **Future research** - improving of **PA grading** by adding sand; application of **PA treatment at higher temperatures** (near to melting point); **improvement of ITZ quality** between PA surface and cement paste by adding of silica fume together with the superplasticizer – this process is also suitable for the improvement of cement stone quality

