RADCON activities at IPPT PAN & joint research topics

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IPPT PAN area of interest

Use of radiation for characterization of composition and properties of concrete

- ❑ comparison of different methods of microstructure characterization (spatial versus plane imaging):

    NI/microtomography/digital optical microscopy

- entrained air void system
- distribution of moisture content (bleeding phenomena)

❑ determination of concrete composition → NI/PPGI
for prediction of radiation shielding

❑ determination of concrete composition and activation analysis → NI/PPGI/ ?
for design and characterization of concrete of low-activation potential

IPPT PAN area of interest

Effect of irradiation on microstructure and properties of concrete

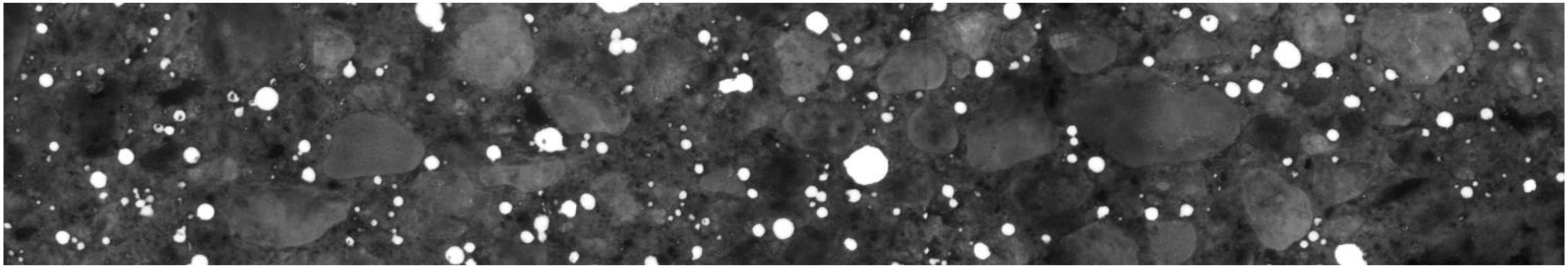
- ❑ high γ dose/high n fluence exposure → deterioration of concrete components (hot specimens!)
- ❑ moderate γ exposure → spent fuel pool
- ❑ short term γ exposure :
- - hardening of cement paste (CZ+ Sosny Minsk)
- - hardening of mortar (PL+ Sosny Minsk)
- ❑ modelling approach to neutron-induced swelling of aggregates, starting with ASR damage description
- ❑ ion implantation studies as a substitute of radiation induced damage

Air void system characterization (1)

PL 2. "Spatial imaging of air-void system in hardened concrete using different tomography techniques"

Participants: BNC, Yonsei Univ., IPPT PAN

The topic is thought to reveal the possibilities of NI and microtomography in characterization of the system of entrained air voids and larger cracks in concrete in comparison to 2D optical microscope digital analysis.



Air void system characterization (2)

Specimens cut out of hardened concrete of 3 different mix design:
a) properly air entrained concrete as required for high frost resistance,
b) air entrained concrete with overdosed/instable air void system that resulted in segregation of air voids,
c) air entrained concrete after numerous years in service resulting in some paste cracking and filling of original air voids with reaction deposits.

Three specimens 20x20x80 mm out of each concrete type.

Air void system characterization (3)

The following stages of investigation are suggested:

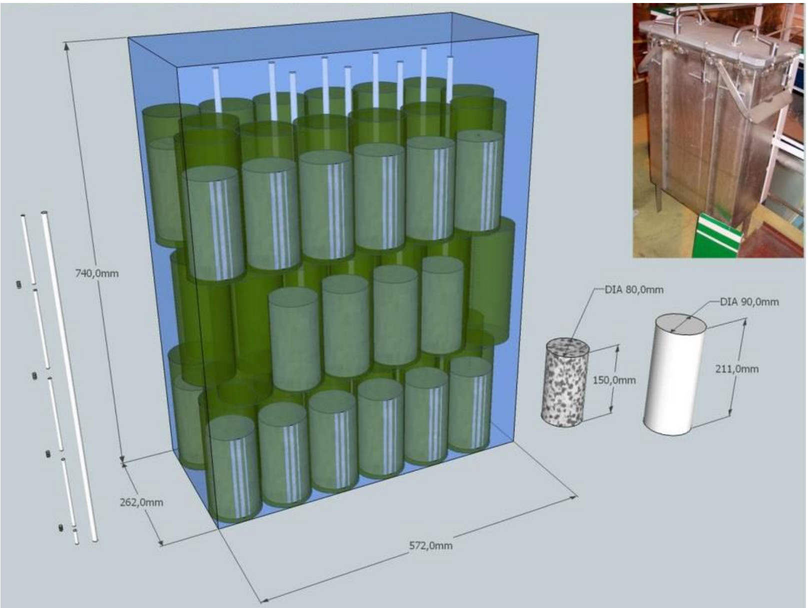
1. Manufacturing specimens at IPPT PAN
2. Microtomographic characterization of specimens at Yonsei University, Seul (Prof.Park)
3. NI/PPGI characterization of specimens at BNC Budapest
4. Optical 2D microstructure characterization at IPPT PAN
5. Joint analysis of data and preparation of publication (all) until 30 Sept.2019

Gamma iradiation in spent fuel pool (1)

The following concrete specimens were exposed to gamma radiation in the spent-fuel pool of research reactor near Warsaw during 12 months.

Designation / [% of volume]	M80	S80	M53 S27	M27 S53	B100	B80	B53 S27	B27 S53
Sand (0-2 mm)	20	20	20	20	-	20	20	20
Magnetite	80	-	53	27	-	-	-	-
Barite	-	-	-	-	100	80	53	27
Serpentinite	-	80	27	53	-	-	27	53
Density of concrete [kg/m^3]	**3600**	**2400**	**3150**	**2800**	**3450**	**3200**	**2950**	**2650**

Gamma iradiation in spent fuel pool (2)



Absorbed gamma dose – about 10^6 Gy

Ozn. Próbki	Dawka (MGy)
B11/1	1,9
B11/2	1,9
B11/3	2,1
B11/4	2,0
B12/1	1,9
B12/2	2,1
B12/3	2,0

Ozn. Próbki	Dawka (MGy)
B13/1	2,0
B13/2	2,1
B13/3	2,1
B13/4	1,8
B14/1	2,0
B14/2	2,0
B14/3	2,4
B14/4	2,1

Ozn. Próbki	Dawka (MGy)
B15/1	2,2
B15/2	2,1
B15/3	2,3
B15/4	2,1
B16/1	2,3
B16/2	2,3
B16/3	2,1
B16/4	2,0

Ozn. Próbki	Dawka (MGy)
B17/1	2,0
B17/2	2,3
B17/3	2,4
B17/4	2,1
B18/1	2,1
B18/2	2,0
B18/3	2,3
B18/4	2,1

Gamma iradiation in spent fuel pool (3)

The same concrete mixes to be manufactured.
After hardening the specimens are to be exposed to the temperature 50 deg. C to compare the effects of gamma irradiation and the elevated temperature.

We are looking for other possibilities of long-term gamma exposure of concrete (mortar) specimens.

High flux neutron iradiation (1)

Just considering such a possibility:

- ❑ small mortar specimens smart selection of composition
- ❑ specimens packed into a capsule and exposed to high flux neutron radiation at (?)
- ❑ target neutron fluence at least 10^{17} n/cm^2 (28 hours * 10^{14} n/c)
- ❑ after irradiation the capsule is removed from the core using the secure transport system, the specimens removed within the safe area
- ❑ surely the specimens are active → transfer to hot cell containing the lenght change measurement device
- ❑ using the remote manipulator a specimen is placed in the length measuring device and the length change due to radiation is obtained

High flux neutron iradiation (2)

the length measuring device

Mortar specimens 15x15x140mm with measuring studs at the ends

IPPT PAN can design and manufacture two such measuring devices:

- for use inside a hot cel (length measurement after irradiation)
- for use outside a hot cel (reference length measurement before irradiation)

The studs and the moulds should be designed as well.

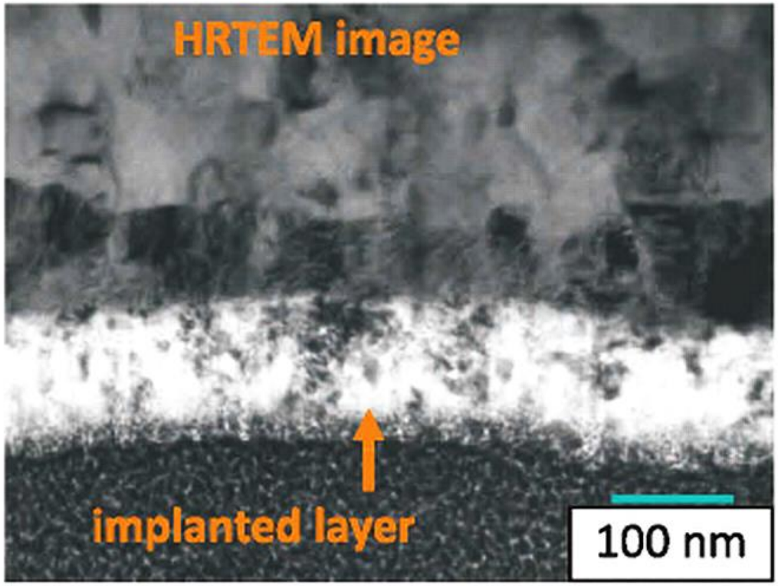
We can deliver devices to the place of irradiation

Ion implantation at IPPT PAN

Tests of shape memory alloys, high speed steels or Ti- alloys. Microstructure, implanted ions distribution and mechanical properties of modified layers are investigated. The goal is an optimal selection of process parameters for different materials.

a)

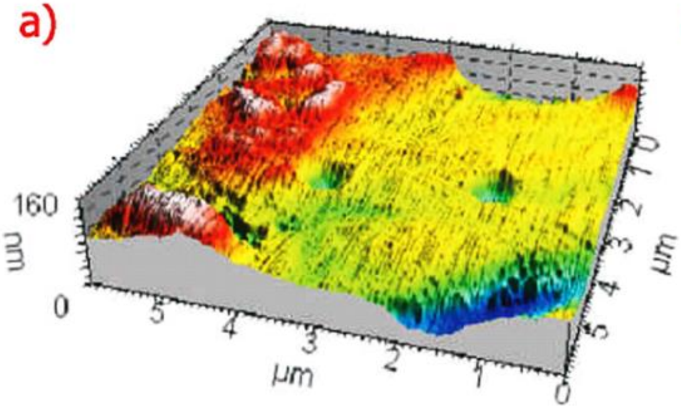
b)



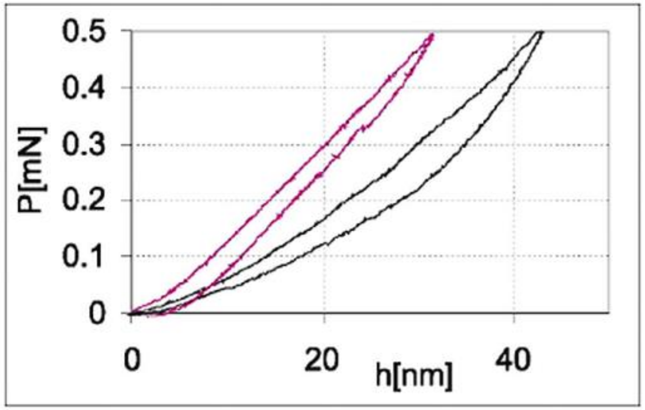
a) Ion implanter, b) morfology of implanted layer.

Identification of material properties using nanoindentation after ion implantation

a)



b)



a) Effect of nanoindentation tests in the metal phase of sintered metal-ceramics composite (Mo+40%Al_2O_3).

b) Nanoindentation curves for ion implanted (red) and non-implanted (black) shape-memory NiTi alloy.

Thank you for your attention

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