Novel Composites based on Cerium Oxide Nanoparticles and Carbon Enterosorbents for Acute Radiation Sickness Therapy

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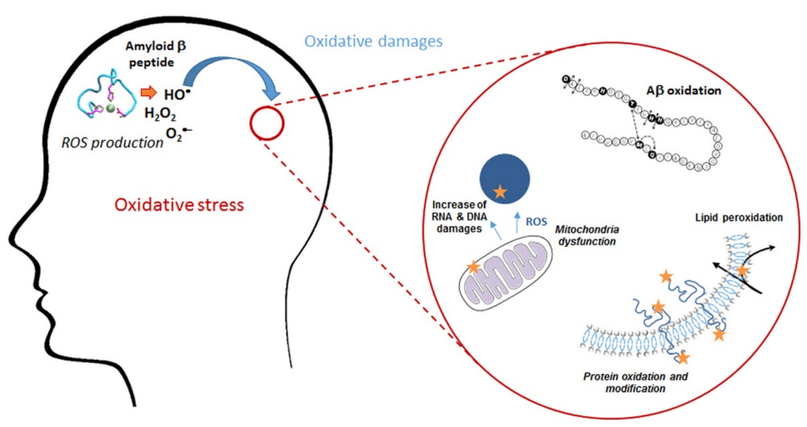
- the risks of large-scale radiation injury of civilian population have significantly increased
- the external ionizing radiation and radiation sickness pose the biggest danger to health -and the most severe is the damage to the hematopoietic system, gastrointestinal tract and central nervous system
- the current view on the mechanism of radiation damage of the living organism - triggered by oxidative stress

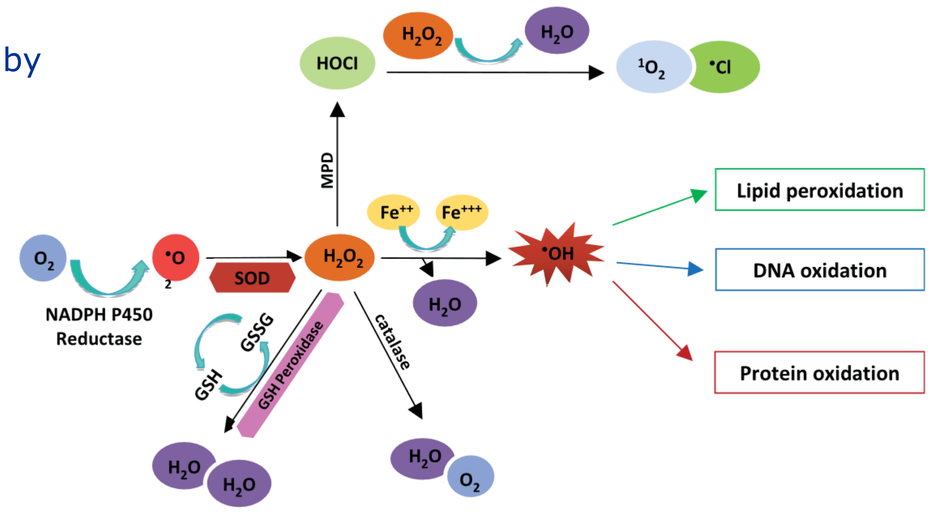


several pathways linking

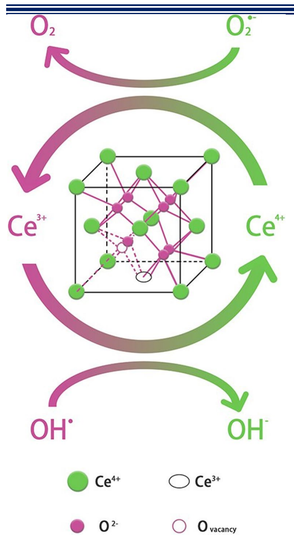
oxidative stress

aging/neurodegenerative diseases

!!! the exact mechanism **is unknown**



CeO_2 nanoparticles for biomedical applications



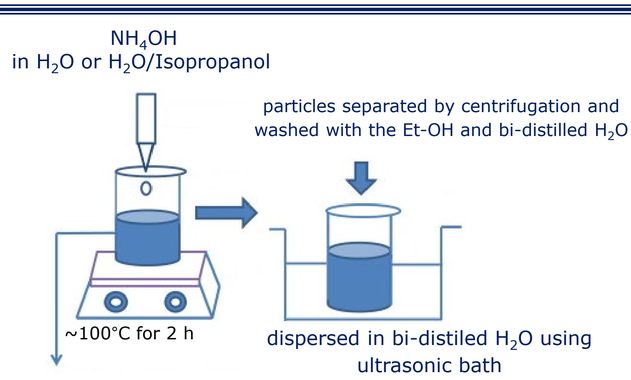
shielded 4f-electrons and low redox potential of the Ce^{4+}/Ce^{3+} redox couple (~1.52 V) → attractive optical, magnetic, and chemical properties

In collaboration with team of prof. Belous (Institute of Inorganic Chemistry NAS, Ukraine)

a new **CeO_2 NPs** were prepared by controlled synthesis:

i) **precipitation aqueous-alcoholic solutions: dd-H_2O+Isopropanol (IPA)** in precisely determined ratios particles Ce1 – Ce5

ii) **precipitation** in a **reverse microemulsion** in the presence of Triton X-100 (CeO_2)



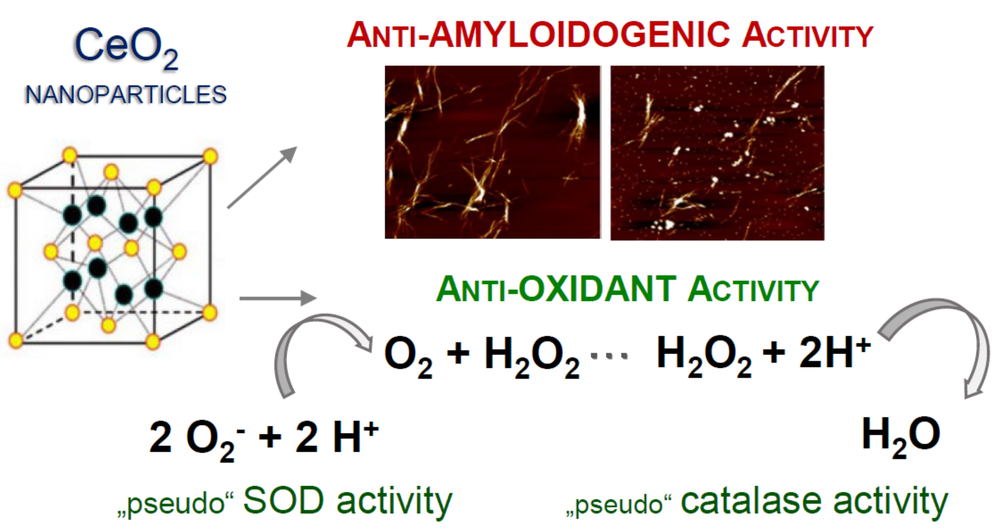
X-ray diffraction (XRD) analysis confirmed formation of ***fluorite Fm3m structure***

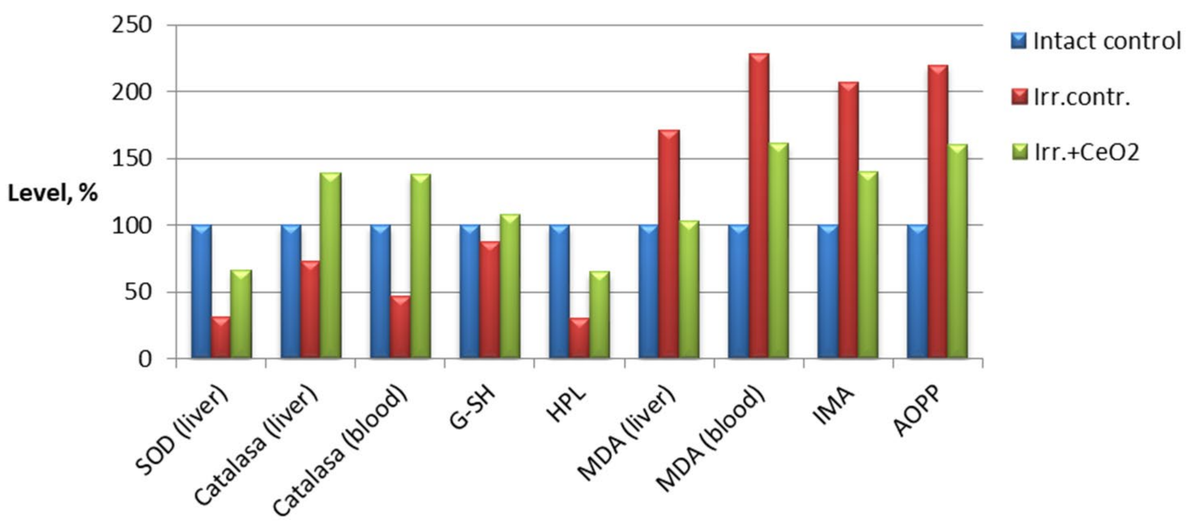
XPS analysis allow to estimate the percentage of Ce^{3+} ions on the surface of CeO_2 NPs

CeO_2 NPs	d_{TEM} [nm]	ζ-potential [mV]	w Ce^{3+} [%]
Ce1	13.4 ± 2,3	+40.9	23
Ce2	8.0 ± 0,8	+41.5	30
Ce3	5.6 ± 0,6	+41.6	35
Ce4	3.5 ± 0,4	+42	38
Ce5	2.8 ± 0,4	+42.9	44
CeO_2	5-6 ± 1	+46.9	28

correlation between size and Ce^{3+}/Ce^{4+} on the surface demonstrated

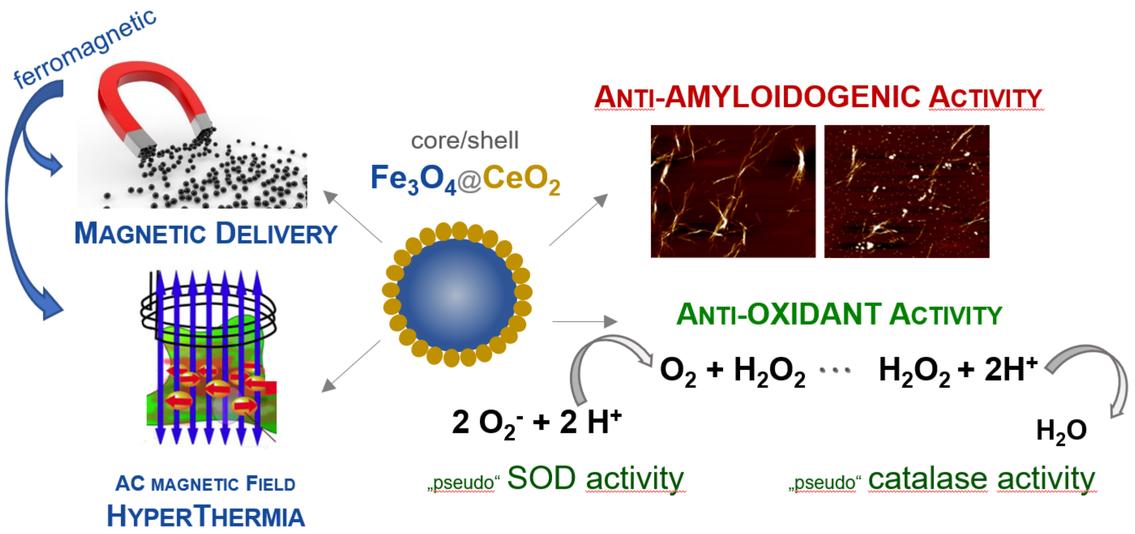
Bioactivity of CeO_2 NPs

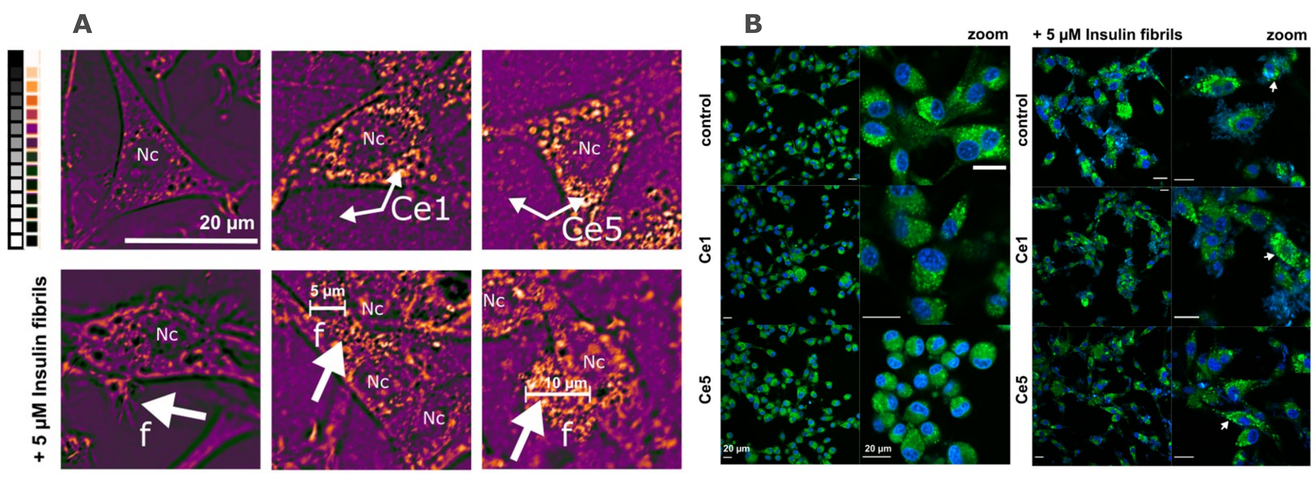




Changes in the indicators of the anti-oxidant/pro-oxidant system induced by irradiation of Rats at a dose 6 Gy and after i.p. injection of CeO_2 NPs
(SuperOxide Dismutase (SOD); Reduced glutathione (G-SH); Hydro Peroxides of Lipids (HPL); Malonic Dialdehyde (MDA); Ischemia-Modified Albumin (IMA); Advanced Oxidation Protein Products (AOPP)

Future plans...





Morphology of U87 MG cells in the presence and absence of insulin fibrils and CeO_2 NPs visualized by confocal microscopy (A) *(presented in inverted contrast for better recognition of the distribution of CeO_2 NPs and vesicles in cells)*

Distribution of lysosomes in U87 MG cells in the presence and absence of CeO_2 NPs and insulin fibrils detected using confocal fluorescence microscopy (B)

Shlapa, Yu.; Timashkov, I.; Veltruska, K.; Siposova, K.; Garcarova, I.; Musatov, A.; Solopan, S.; Kubovcikova, M.; Belous, A. Structural and Physical-Chemical Characterization of Redox Active CeO_2 Nanoparticles Synthesized by the Precipitation in the Water-Alcohol Solutions. *Nanotechnology*. 2021, 32, 315706 (9pp)
Sarnatskaya, V.; Shlapa, Y.; Lykhova, A.; Brieieva, O.; Prokopenko, I.; Sidorenko, A.; Solopan, S.; Kolesnik, D.; Belous, A.; Nikolaev, V. Structure and biological activity of micro- nanoparticles produced from highly activated carbonic adsorbent. In *Heliyon*, 2021 (*in press*).
Siposova, K.; Huntosova, V.; Garcarova, I.; Shlapa, Yu.; Timashkov, I; Belous, A.; Musatov, A. Multifunctional, Anti-oxidant and Anti-amyloidogenic Cerium Oxide Nanoparticles Prepared by Controllable Precipitation in Water-Alcohol Solutions. (*to be submitted*).