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# REVEALING, TYPIFYING AND ASSESSING FLAWS AND AGE-RELATED DEGRADATION IN NUCLEAR POWER PLANT CONTAINMENTS USING THE QUANTITATIVE ACOUSTIC EMISSION NON-DESTRUCTIVE INSPECTION METHOD

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## ABSTRACT

Providing safety of reinforced concrete containments is one of the main challenges of the nuclear industry. This is because:

- Concrete degradation, decreasing compressive, tensile and yield strengths, macro- and micro-cracks, fatigue cracks, de-bonding reinforcement, spallation and porosity reduce the fracture toughness, change the magnitude and orientation of the main stresses, and decrease the load-carrying capabilities of structures.
- Dehydration of cement stone, due to temperature, radiation, leaching of calcium hydroxide from the concrete, sulfate attack, alkali-aggregate reaction and subsequent swelling, is evaluated currently by traditional local NDE methods with low accuracy.
- Revealing corrosion location and determination of its type and danger level in reinforced or pre-stressed concrete containments is not performed on a regular basis.
- Movement of soil under the containment base is evaluated only when there are visible indications of damage.

The situation is even worse because existing Non-Destructive Inspection (NDI) methods provide limited information and are not suitable for revealing, identifying and assessment of flaws in structural elements of nuclear power plant containments. To solve the above-mentioned problems, the authors have created and successfully used for different applications the Quantitative Acoustic Emission Non-Destructive Inspection technology (QAE NDI). The results of the investigations presented below demonstrate the capabilities, advantages and limitations of QAE NDI technology for revealing, typifying, and assessing flaws and age-related degradation in nuclear power plant containments.

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# SOLID-PHASE REACTION AT ION IMPLANTATION OF NITROGEN, OXYGEN IN REFRACTORY METALS

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## ABSTRACT

The purpose of the research is to study the mechanisms of structural and phase transformations in superficial layers of transitive metals at ion implantation and further heat treatment. As base methods of the structure research of irradiated and non-irradiated materials have been used the approved methods of X-ray-structure analysis with the use of narrow sliding monochromatic $CuK_{\alpha}$-radiation and Rutherford backscattering. The experimental results allow to make the following conclusions: the basic laws of structural and phase transformations in the transitive metals (tungsten and tantalum) are established at their implantation by the ions of the elements which form introduction phases (nitrogen, oxygen and phosphorus); it is revealed that the mechanism of structural and phase transformations is determined, generally by the dimensional factor and slightly depends on physical and chemical properties and kinetic parameters of bombarding elements; it is revealed that the implantation of tungsten and tantalum by oxygen ions results in formation of highly packed structures which have been identified in the work as $W_2O$ and TaO oxides.

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# THE FEATURES OF MAGNETIC AND STRUCTURAL PROPERTIES IN Fe–Mn–C ALLOYS AFTER DYNAMIC LOADING

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## ABSTRACT

The magnetic and structural properties in in the 110G13L steel have been investigated after dynamic loading. The occurrence of magnetization and magnetic viscosity under dynamic load of samples quenched to austenite have been revealed.

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# THE NANOSTRUCTURES IN THE Ni –Cr AND Co-Cr -BASED COATINGS DEPOSITED BY PLASMA DETONATION AND THE MODIFICATION OF COATINGS' MECHANICAL PROPERTIES BY DUPLEX TREATMENT

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## ABSTRACT

This paper presents the results of experimental investigation of the structure-phase state and mechanical properties of Ni-Cr and Co-Cr-based composite powder coatings. The coatings were deposited on stainless substrates by plasma detonation in air. The coated samples were exposed to e-beam in vacuum or re-exposed to pulsed plasma jet without powder coating. The main experiment methods were selected as follows: Transmission Electron Microscopy (TEM), topography by Atomic Force Microscopy (AFM) , X-Ray photoelectron spectroscopy, Electron Spectroscopy for Chemical Analysis (ESCA), Scanning Electron Microscopy (SEM) with Electronic Data Systems ( EDS), **X-ray diffraction** (XRD),, micro-hardness measurement, wear and corrosion tests. It was empirically established that before irradiation the PG-19N-01 coating consists of Ni-based nanocrystalline γ-phase and $CrNi_3$ microcrystalline phase. We defined the size of nanograins and microcrystallites, the types and parameters of their lattices. It was found that depositing PG-10N-01, PG-19N-01, and AN-35 powder coatings by plasma detonation with the duplex treatment of surface results in forming multi-phase dense coatings with intermetallic hardening compounds, oxides and carbides. The coatings are hard, sea water corrosion resistant and wear resistant.

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# X-RAY FLUORESCENT ANALYSIS OF RUBBER CONCRETE PYROLYZATE

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## ABSTRACT

The results of X-ray fluorescence analysis of **pyrolyzate of rubber concretes** based on liquid butadiene oligomers of types SKDN-N and PBN. The element compositions of initial and burnt rubber binders are determined.

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# PARACRYSTALLINITY OF CELLULOSE

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## ABSTRACT

The paracrystallinity of cellulose samples was studied by complex of investigation methods including X-ray, NMR, sorption, calorimetry and some others. It was found that the paracrystalline fraction of cellulose is located on surface of crystallites as thin monomolecular layers having average thickness of 0.4 nm. The paracrystalline surface layers have distorted and loose packaging that is characterized by high distortion parameter $\delta_p$ = 0.18, increased specific volume $V_p$=0.664 $cm^3/g$ and decreased specific gravity $\rho_p$= 1.51 $g/cm^3$. The quantitative characteristic of the paracrystalline fraction is its part in crystallite (α) that has an expressed influence on some properties of cellulose. Increasing of the α-value causes expansion of inter-plane distances in the C1 unit cell, as well as promotes mercerization and dissolution of cellulose.

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# SURFACE STRENGTHENING OF POLYMER CONSTRUCTION MATERIALS BY DIFFUSION MODIFICATION

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## ABSTRACT

The main features of diffusion modification of both linear and network polymers by reactive furan oligomers for the purpose to enhance the surface properties of materials are considered

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# STRUCTURE AND PROPERTIES OF NANOCOMPOSITE PROTECTIVE COATINGS BASED ON Ti-N-Cr/Ni-Cr-B-Si-Mo

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## ABSTRACT

First results on manufacturing and investigations of a new type nanocomposite protective coatings are presented. They were manufactured using a combination of two technologies: plasma-detonation coating deposition with the help of plasma jets and thin coating vacuum-arc deposition. We investigated the structure, morphology, physical and mechanical properties of the coatings of 80 to 90μm thickness, as well as defined the hardness, elastic Young modulus and their corrosion resistance in different media. Grain dimensions of the nanocomposite coatings on Ti-N-Cr base varied from 2.8 to 4nm. The following phases and compounds formed as a result of plasma interaction with the thick coating surface were found in the coatings: Ti-N-Cr (220), γ-$Ni_3$-Fe, a hexagonal $Cr_2$-Ti, $Fe_3$-Ni, (Fe, Ni)N and the following Ti-Ni compounds: $Ti_2Ni$, $Ni_3Ti$, $Ni_4Ti$, etc. We also found that the nanocomposite coating microhardness increased to 32±1.1 GPa. The Young elastic modulus was determined to be 320±20 GPa - it was derived from the loading-unloading curves. The protective coating demonstrated the increased corrosion resistance in acidic and alkaline media in comparison with that of the stainless steel substrate.

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# RESEARCH OF THE NANOMODIFIED ADMIXTURE AND ITS INFLUENCE ON THE CHARACTERISTICS OF THE FINE-GRANED CONCRETE

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## ABSTRACT

Structure of the fine-grained concrete modified by nanostuctured admixture- sol of silica acid is investigated. The sol is used for creation an additional structural element into the concrete mix. This element (silica nanoparticles) reacts with $Ca(OH)_2$ forming hydro silicate of calcium that leads to filling of pores by silica nanoparticles and the reaction products. Thus physical-mechanical and chemical resistance of the modified concrete are improved**.**

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# COMPOSITES BASED ON EPOXY RESINS FILLED WITH MODIFIED BENTONITE

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## ABSTRACT

Ultimate strength, softening temperature, and water absorption of the polymer composites based on dian epoxy resin (type ED-20) and unmodified and modified by tetraethoxysilane mineral bentonite are described. Comparison of experimental results obtained for investigated composites shows that ones containing modified filler have more high values of mentioned above parameters than composites with unmodified filler at definite loading. The maximum of ultimate strength for composites with modified filler is higher than that for composites with unmodified filler. First composites have also higher softening temperature and lower water absorption. Experimental results are explained in terms of structural peculiarities of polymer composites.

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# DEHYDROCOUPLING AND HYDROSILYLATION REACTIONS OF METHYLHYDROSILOXANE TO ALLYL ALCOHOL

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**ABSTRACT**

Dehydrocoupling reaction of α,ω–bis(trimethylsiloxy)methylhydrosiloxane (n≈53) with allyl alcohol at various ratio of initial compounds, in the presence of anhydrous powder like caustic potassium and platinum hydrochloric acid has been investigated. It was established that in the presence of caustic potassium dehydrocoupling reaction takes place and methylsiloxane oligomers with oxyallyl side groups have been obtained. In the presence of platinum hydrochloric acid competitive dehydrocoupling and hydrosilylation reactions take place with formation of oligomers with various link of chain. In high stages of reaction three-dimensional systems were obtained. During dehydrocoupling the reaction order, rate constants and activation energy were found. The structure of synthesized oligomers was determined by FTIR and NMR spectra data. Gel permeation chromatographic, differential scanning calorimetric and wide angle X-ray analysis of synthesized oligomers were carried out.

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# NANOMODIFIED BITUMEN EMULSION FOR CONSTRUCTION PURPOSES

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## ABSTRACT

The new anion active bitumen emulsion (BE) has been developed; their properties have been studied and composition optimized. The nano modification and BE filling by latex and different filler had been carried out. The anticorrosion protection of metal communication and supporting formwork system made of brick and concrete by means of elaborated compositions were performed.

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# THE ATOMIC SHORT RANGE ORDER PARAMETERS IN THE FILMS OF TRIPLE COMPOUNDS *Cu – In – S(Te)* SYSTEM

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## ABSTRACT

In present work, the results of electrondiffraction investigations of structures of amorphous thin films of Cu – In – S(Te) systems have given and function of radial distribution of atoms (FRDA) have been calculated. There are three maximums on curves of radial distribution of atoms of $CuInS_2$ and $CuInTe_2$ amorphous films: at $r_1$=0,250; $r_2$=0,262; $r_3$=0,380 and $r_1$=0,285; $r_2$=0,293; $r_3$=0,418nm respectively. The areas under according maximums equals: Δ=25,7; 39,5; 55,6 and 33,0; 46,6; 70,2. It is find that atoms of matrix of $CuInS_2$ and $CuInTe_2$ amorphous films are tetrahedral and octahedral environments. By this fact it is established, that the change of structural unit forms the character of their packing and take place in the region of second coordination sphere that leads to more solid packing of structural dimmers in $CuInTe_2$

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# WEAR-RESISTANT COATINGS ON THE BASIS OF OLIGODIENES

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## ABSTRACT

The ways of increase of wear resistance of polymer protective layers under abrasive wear conditions are considered. The formulations of protective compositions tolerant to joint action of temperature and corrosive slurry are presented.

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# THE RISKS CONNECTED WITH USE OF POLYMERIC NANOSTRUCTURES IN TECHNOLOGIES OF SEEDS TREATMENT BEFORE SOWING

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## ABSTRACT

The creation and use of nanotechnologies in the first place provides their interaction with ecosystems and alive organism. Currently it is actual the problem of a risk use of nanoparticles and nanotechnologies in different sphere of human activity. We tried to learn the influence the nanotechnology of preparation the seeds before sowing on natural nanoobject - a seed of the plants. Thus considering the seed unique adaptive properties, high reliability to environment factors action, the seed (as an dissipative system) can be considered as nanostructure possessing nanoproperties. On the mechanism considered realizing in the resting seed and at the outcome from the rest it can be expected that these mechanisms promote the formation native nanoobject -the seed. The method of the seed treatment with polymers which use allows to increase the seed reliability to realize the mechanism regulating the velocity of water inflow into the seed and the processes underlying in the base of it sowing as well as the seed sprouting allows to consider it as a nanotechnology and polymeric cowers (depending on their nature, molecular mass, concentration etc)at the definite conditions the seeds presowing treatments as nanomaterial which allows to change significantly the properties of the seed as a native nanoobject. For estimation risk of the use nanotechnology of preparation the seeds to the sowing we used some models, describing operating the alive systems (seed) and role of the covering in different phase of the seed development.

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# CHEMICAL TAGGING INDICATORS FOR IDENTIFICATION OF OVERHEATED PLACES IN POWER TRANSFORMERS

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## ABSTRACT

The purpose of this article is to develop chemical indicators for identification of overheated places in power transformer with mineral oil. The chemical indicators, which are suitable to be placed on potential trouble spots, and release specific substances when exposed to predefined temperatures and allow early diagnostics and identification of. It was elaborated copolymers of methacrylic esters as chemical indicators in power transformers with mineral oil. The indicators are not soluble in mineral oil. Decomposition of network copolymers gives high yields of methacrylate monomer (85-95%). The monomers in mineral oil are determined by GC (Gas Chromatograph). A sample of scheme of card of applying indicators is recommended for industrial power transformers.

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# HIGH-ENERGY PHYSICAL EFFECTS AT FORMATION OF COMPOSITE MATERIALS

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## ABSTRACT

The composite material with anisotropy of electric conductance 2.05 in mutually perpendicular direction is formed into polycrystalline conducting materials in the process of superdeep penetration of solid microparticles. Such high-energy effects as formation of "galactic" ions, microstreams of dense plasma, pulse electric fields is accompanied this process.