Decontamination Techniques Evaluation

ISTC Partnership Project # 2042

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#2042

Two decontamination methods with low radioactive waste formation hoosen for demonstration:

- *Electrochemical with external electrode;*
- *Strippable coatings based on water-soluble PVA with additives.*

1. Electrochemical decontamination of SIMCON specimens from INEEL

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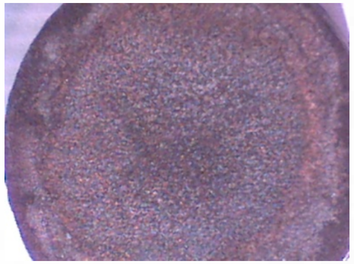
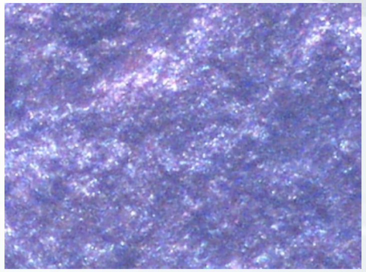
Effectiveness of electrochemical decontamination method checked using SIMCON coupons from INEEL. SIMCON is a specimen artificially contaminated with stable isotopes. Coupons were round metallic pellets 25.7 mm in dia, 6.5 mm thick.

Because of the lack of qualitative and quantitative data on SIMCON coupons contaminants, the decontamination effectiveness was assessed from the weight loss after anodic decontamination and with a light microscope with magnification of 10, 60 and 200.

SIMCON DECONTAMINATION

Sample	initial		Final	
	x10	x200	x10	x200
H-A 004				

H-D 035

Efficiency of Electrochemical decontamination for specimens SIMCON

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##	Initial Conc. Cs, µg	Final Conc. Cs, µg	% Clean	Initial Conc. Zr, µg	Final Conc. Zr, µg	% Clean	Time, min.
003	74	3	96	129	3	98	30
006	79	3	96	142	3	98	30
007	65	3	95	100	3	97	30
009	55	24	56	116	64	45	15
020	72	3	96	73	3	96	30
030	48	3	94	123	3	98	10
035	45	3	93	121	5	96	10
012	51	3	94	68	3	96	10
036	48	3	94	55	3	95	10
038	50	3	94	59	3	95	10

Electrochemical decontamination: 3 options

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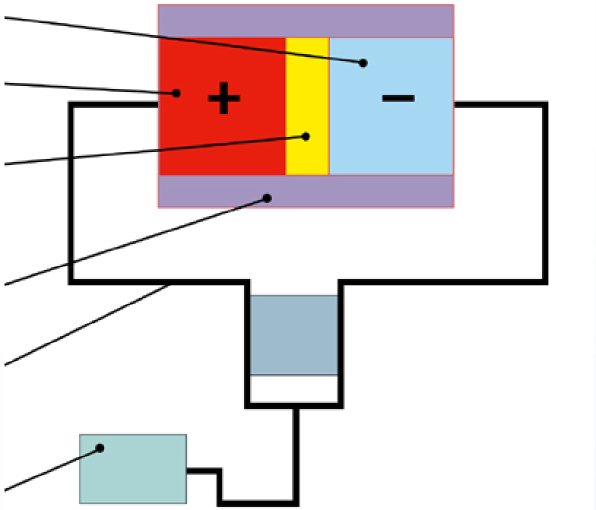
Our team developed and tested new tools: an external/remote electrode:

- *bipolar decontamination of non-conducting surfaces by various electrolytes;*
- *effective electrochemical decontamination of carbon steel using reverse current in neutral salt solutions.*
- *electrochemical dissolution of the contaminated metallic and non-metallic surfaces in combination with radionuclide sorption using ion exchange materials*



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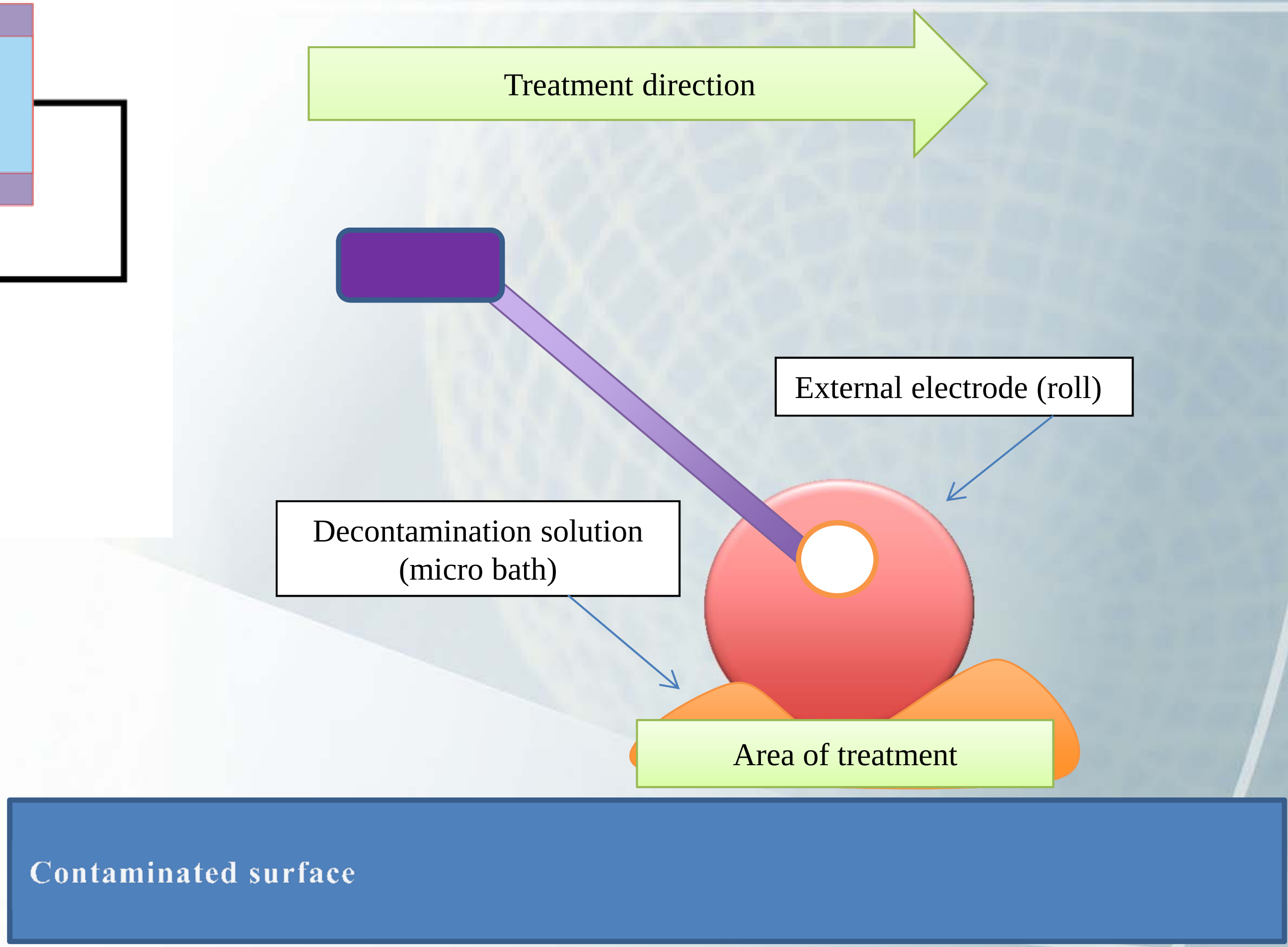

Treatment direction
External electrode (roll)
Decontamination solution (micro bath)
Area of treatment
Contaminated surface

Improvement vs conventional technologies

- ***Traditionally this method realized in baths of different volume.***
- *Exclusion of big volumes of secondary radioactive liquid waste as result of using of "micro bath" between external electrode (roll or other design) and possibility to treat equipment "on-site" without fragmentation is the key difference with traditionally application of electrochemical techniques and tools*

Electrochemical decontamination with external electrode

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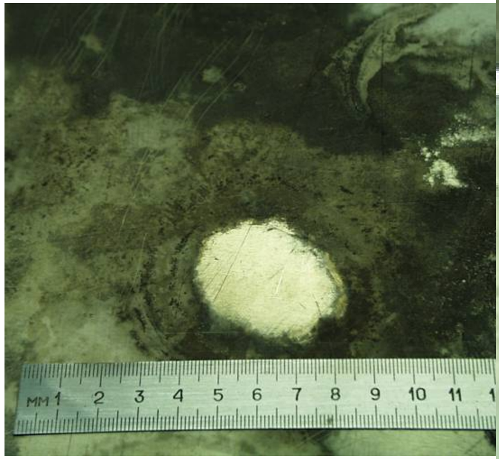
The electrochemical decontamination using an external electrode consists in creation on the treated surface of "micro bath" in which electrolyze are proceeds. Decontamination carry out consecutive moving of "micro bath" on a metal surface. Solutions of mineral acids (nitric, sulfuric, phosphoric) use as electrolytes; current density is 10-20 A/dm^2.



Application:

for metallic or plastic surface; gloveboxes, hot cells, floors and stairs

2. Strippable Coatings

Strippable polymeric coatings are divided in 2:

- Protective coatings: active additions allow complex forming agents and sorbents which react with radionuclides trapped to isolate them by fixing in a stiff nonvolatile form
- Effective decontaminating coatings call for aggressive ingredients like mineral and organic acids, oxidants and alkaline metal hydroxides

Preparation of polymers:

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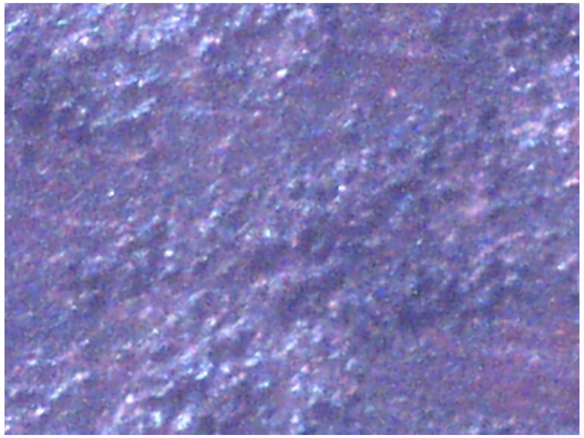
- *It takes 4-8 hours for a polymeric coat ~100 μm thick to be produced at 20 C and a humidity of 70%, the stock consumption being 0.25-0.5 l/m^2. The coat remains protective for more than 100 days. The coat adhesion to surfaces of flexible PVC, carbon steel, stainless steel or paintwork is 1-2 g/cm^2.*

Decontamination Factor (DF):

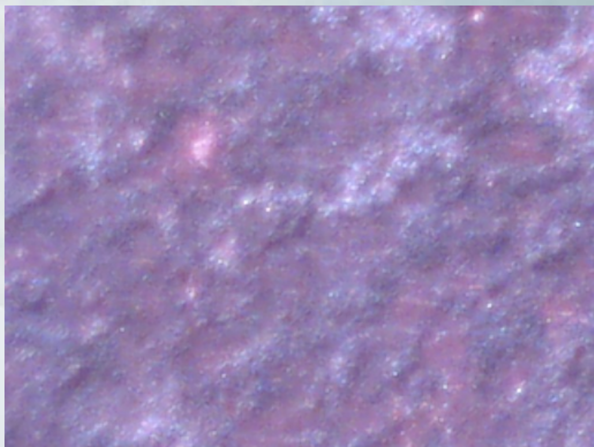
carbon steel	*– 10-20*
stainless steel	*– 20-50*
concrete, bricks	*– 5-7*

Strippable coating decontamination (View of decontamination strippable coatings with metal oxides)

SIMCON DECONTAMINATION (TDP-1)

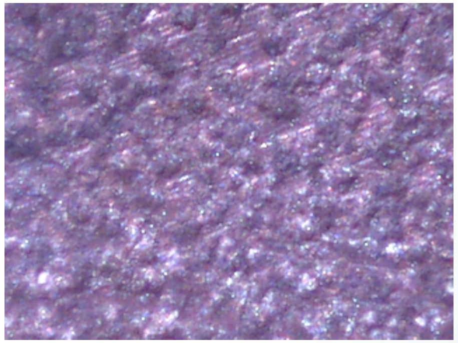


Uncoated **H-A** *002 (x60)*

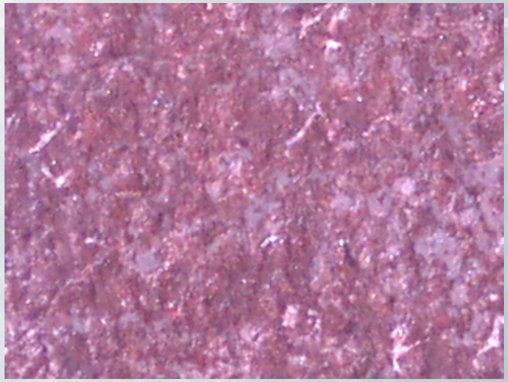


H-A *002 Surface*
after the 1st cycle (x200)

SIMCON DECONTAMINATION (TDP-2)

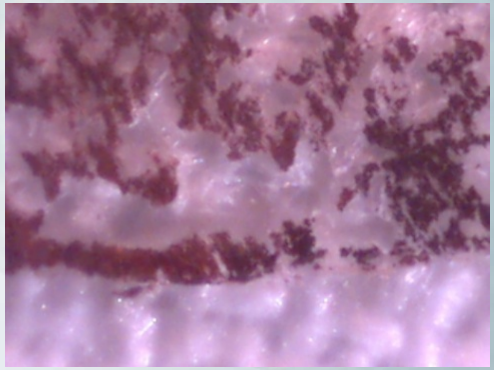


The initial H-D 019 (x 60)



After decontamination (x 60)

Coupon and gauze-reinforced coatings



gauze-reinforced coatings (x 60)

Decontamination efficiency of strippable coatings with SIMCON.

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##	Initial Conc. Cs ug	Final Conc. Cs ug	% Clean	Initial Conc. Zr ug	Final Conc. Zr ug	% Clean
002	61	15	75	73	32	56
005	72	3	96	123	3	98
010	51	4	92	130	15	88
014	98	3	97	121	7	94
016	48	3	94	101	3	97
019	60	10	83	152	51	66
024	52	3	94	94	3	97
033	47	3	94	107	4	96
034	44	3	93	151	3	98
039	101	3	94	68	3	96

Progress after Project #2042

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ВНИИНМ
имени А.А.Бочвара

The Moscow State University (MSU)

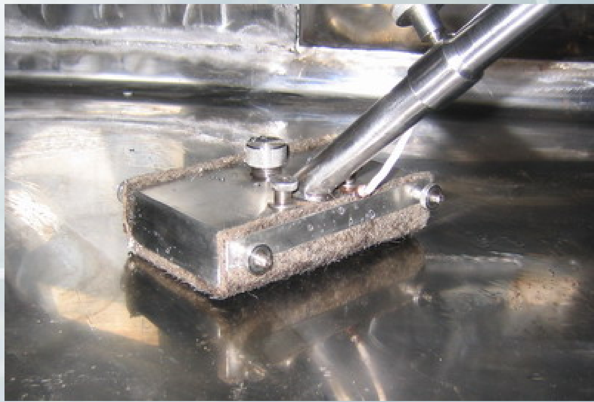
The Moscow State Unitarian Enterprise

Incorporated Ecological-Technological and Scientific Research Centre on RW utilization and security

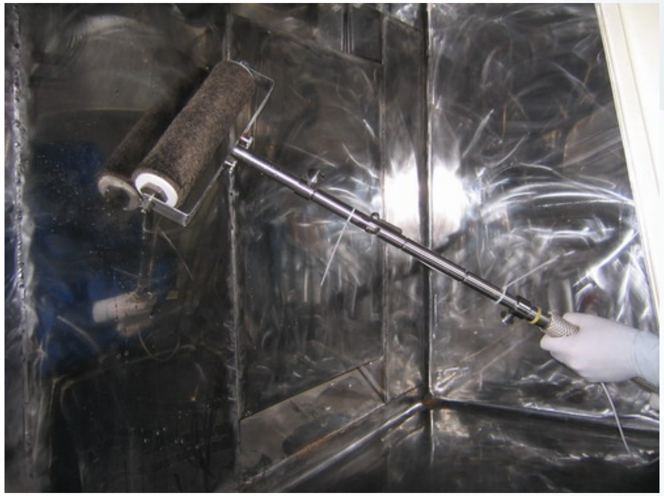
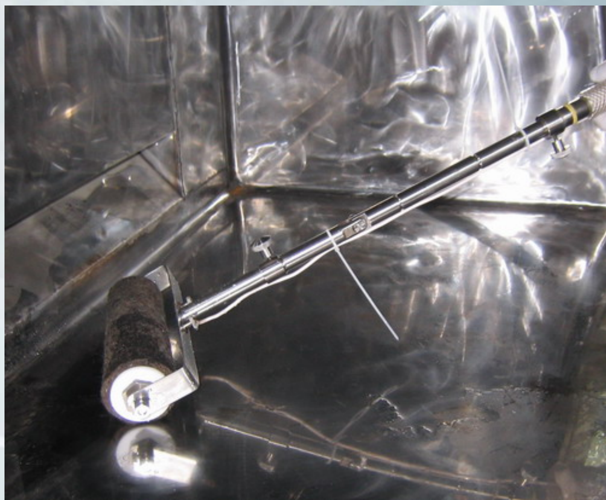
(Mos SIA “Radon”)

www.radon.ru





The handy tools represented external simple electrode with ion exchange material and electrode - roller subdivided to 2 parallel electrodes with special external felt seal. The felt seal served for constant nutrition of process with electrolyte solution. Sorbents with capacity 2-3 mg-eq/g were used for tests

Application of electrodes for decontamination of glove box

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Electrochemical decontamination of stainless steel (Roll)

Contamination, Bq/cm^2		Decontamination Factor
Initial	After treatment	
85,0	0,1	850
69,0	0,1	690
77,0	0,1	770
56,8	0,1	568
63,6	0,1	636

On the basis of laboratory, testing of handy electrodes was made. Samples from stainless steel 12Ch18N10T contaminated with UO_2 were used for pilot tests.

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Electrochemical ion-exchange decontamination of stainless steel (flat electrode)

Results of pilot tests have shown high efficiency of handy tools in the case of it application on stainless steel contaminated with UO_2. The advantage of these techniques and tools is the possibility to decontaminate large metal surfaces without fragmentation.

Contamination, Bq/cm^2 Initial	After treatment	Decontamination Factor
93.2	0,1	932
61.3	0,1	613
88.5	0,1	885
48.9	0,1	489
56.8	0,1	568

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Strippable coatings (after ISTC #2042)

Improvement vs conventional technologies

Developed and tested polymeric strippable coatings based on PVA and polymeric microgels includes aggressive additives which treat contaminated surface during process of water dry-up and polymerization of films. Contamination is incorporated into polymeric films and fixed inside it.

Efficiency of polymeric films for decontamination of SS samples

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#	Contamination, Bq/cm^2		DF
	Initial	Final	
1	240	2	120
2	400	5	80
3	450	3	150
4	330	3	110
5	560	2	280
6	300	5	60
7	425	5	85
8	400	4	100
9	560	4	140
10	480	3	160

Application of strippable coatings for decontamination of glove boxes

Reinforced coat

After decontamination

Removing of polymeric film - decontamination

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Removing of polymeric film - decontamination

Conclusions

1. Results of Project #2042 have shown high efficiency of electrochemical decontamination and strippable coatings in laboratory;

2. After-project activity already implemented: new polymers, new tools, application in actual decontamination activities;

Proposal

Further development for Fukushima needs:

- *Modernization of polymeric films with higher mechanical strength and its localization to Japan commercial polymers;*
- *Creation of industrial-scale commercial tools for electrochemical decontamination with external electrodes;*
- *Development of technology and equipment for electrochemical decontamination of concrete.*

Proposals for Fukushima Daiichi NPP

1. *Decontamination of bulky equipment, constructions etc. "on-site" with electrochemical decontamination using external electrodes;*
2. *Fixation and decontamination of equipment and service rooms inside Daiichi NPP with polymeric strippable coatings*

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Thank you for your attention!

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