Structure and properties of paint coatings irradiated by ultraviolet light

Natalia Valko

Yanka Kupala State University of Grodno
Belarus

INTRODUCTION

There is some interest to methods of paint coatings formation under energy effect, particularly using the UV- irradiation.

It is known that the UV- irradiation causes polymerization processes of paints due the generation of reactive species in it under exposure of organic molecules.

Objective

Investigation of the influence of the UV-light on structure and operational properties of paint coatings formed from the industrial EP-773 two-component epoxy enamel containing hollow glass microspheres.

Object of the study

The industrial two-component epoxy enamel EP-773.
As a modifier were used hollow glass microspheres Q cel 6048 which characterized of 0.27g/cm^3 bulk density and diameter equaled 60μm.

THE EXPERIMENTAL PROCEDURE

Coating has been cured at the temperature of 120° C during 1.5 hours.

The KrBr* excilamp (IHCE SB RAS, Tomsk, Russia) emitting ultraviolet light with the wavelength of 207 nm has been used for irradiating coatings. The excilamp has a radiation power density of 5 mW/cm^2 .

Protective properties of paint coatings were determined accordingly to the standard method:

hardness (GOST 5233),

impact strength (GOST 4765),

adhesion by the method of grating notches (GOST 15140),

gloss (GOST 52663),

water absorption (GOST 4650),

hiding power (GOST 8784),

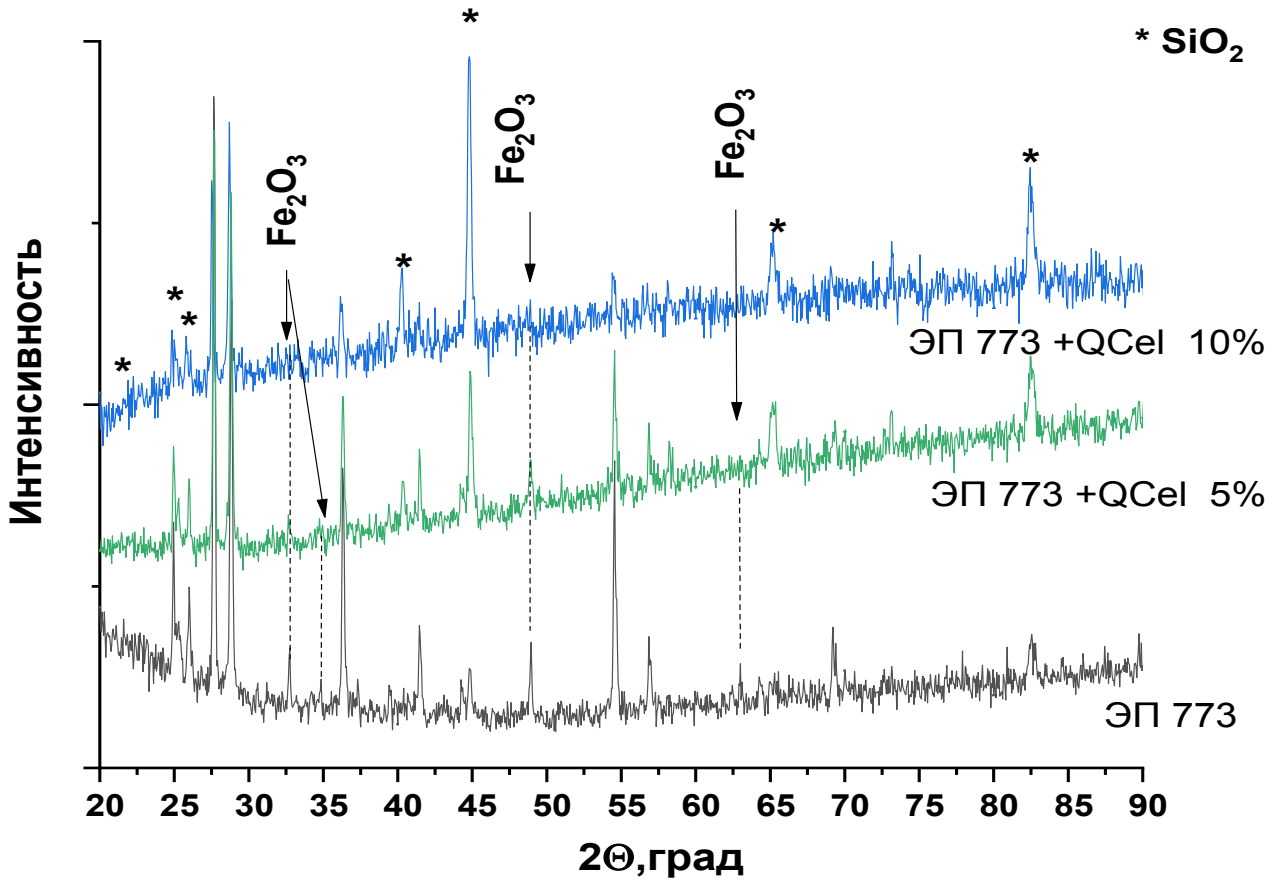
drying time to the third degree (GOST 19007).

The surface morphology and **elemental composition** were studied with JSM-5610 LV scanning electron microscope equipped with EDX JED-2201 chemical analysis system (JEOL, Japan). Accelerating voltage was 20 kV. The phase composition was studied by X-ray diffraction (XRD) on a DRON-3M diffractometer in the Cu Kα radiation. Microhardness of the coating surface was measured on a CASON-59 HV microhardness tester.

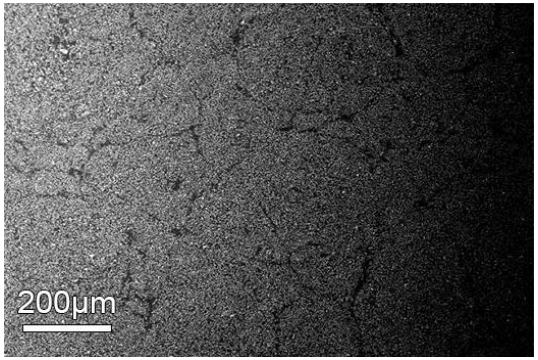
MAIN CHARACTERISTICS OF COATINGS FORMED FROM THE EP-773 EPOXY ENAMEL WITH MICROSPHERES Q-CEL 6048

Content of microspheres,%	Q-cel 6048		
	0%	5%	10%
Mass fraction nonvolatile substances,%	61,2	65,4	66,3
Conditional viscosity by the VZ-246 viscometer with a nozzle diameter of 4 mm at a temperature (120±0,5) °C	80	95	120
Drying time to degree 3 at a temperature of (120±2) °C	37	32	30
Adhesion of film, points	1	1	1
Impact Resistance , cm	90	90	90
The hardness of the film on a pendulum device type TML, usl. units	0,44	0,47	0,51
Moisture absorption	1,61	1,43	1,33
paint sheen, %	41,5	10,1	5,2

COATINGS XRD FORMED FROM THE EP-773 EPOXY ENAMEL WITH MICROSPHERES Q-CEL 6048



MAIN CHARACTERISTICS OF COATINGS FORMED FROM THE EP-773 EPOXY ENAMEL WITH MICROSPHERES Q-CEL 6048

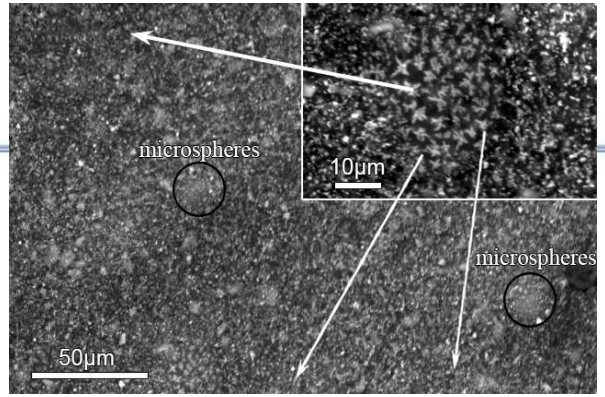


epoxy enamel
EP-773 EP-773

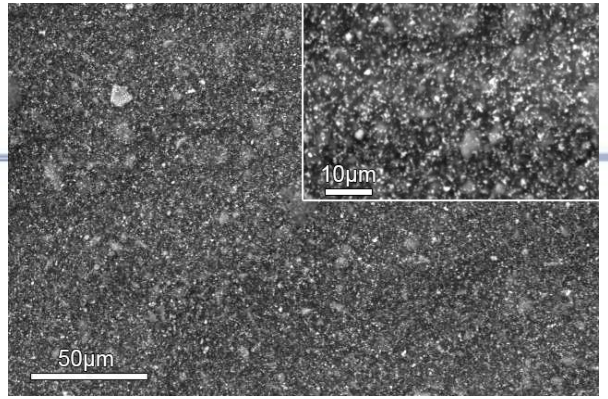
Content of microspheres,%	The hardness of the film on a pendulum device type TML, usl. units.			Adhesion, points	Impact Resistance , cm
	refference	After UV Irradiation	After week after UV Irradiation		
0%	0,44	0,42	0.48	1	90
5%	0,47	0.45	0.53	1	100
10%	0,51	0,50	0.53	1	100

Comparative study of surface morphology of the EP-773 enamel coatings and the same modified with microspheres showed that the EP-773 enamel coats are heterogeneous with micro-holes and cracks on the surface. It is obvious that the presence of microholes and cracks on the surface of paint coatings is associated with the occurrence of internal stresses due to their curing.

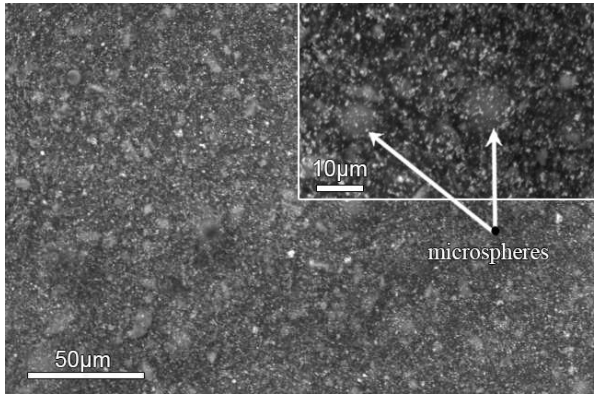
SURFACE MORPHOLOGY



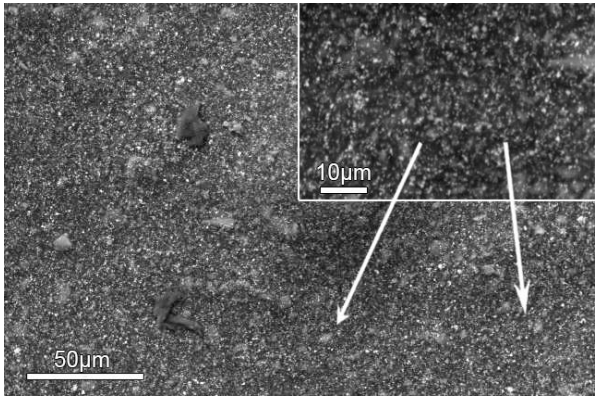
SEM image of the paint coating with 10% microspheres irradiated UV rays



. SEM image of the paint coating with 5% microspheres irradiated UV rays



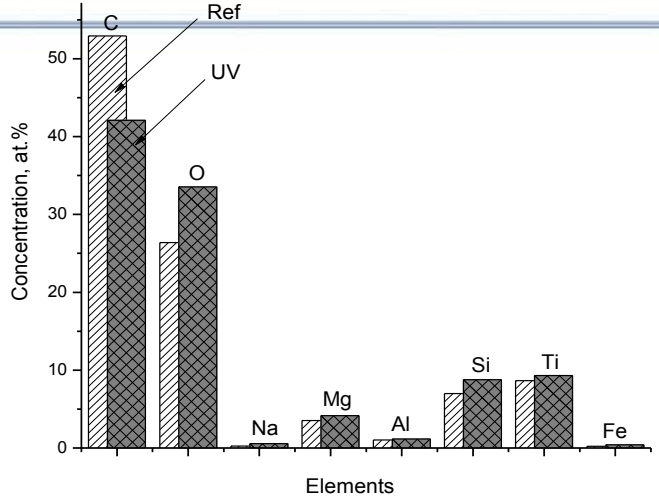
SEM image of the reference paint coating with 10%



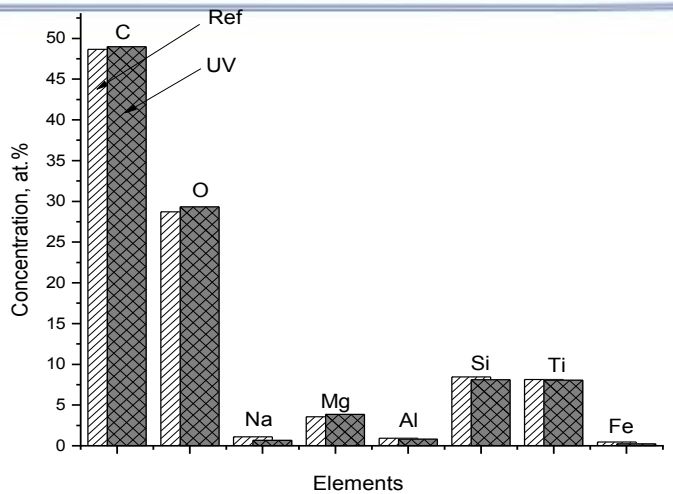
SEM image of the reference paint coating with 5% microspheres

SEM images of surface the EP-773 enamel coatings modified with Q - cel 6048 hollow glass microspheres and irradiated with UV light show that irradiated samples are visually smooth, semi-gloss, without sagging, cracks and inclusions.

ELEMENTAL COMPOSITION PAINT COATING



The elemental composition (at.%) of nonirradiated paint coating on an 08kp steel.



The elemental composition (at.%) of paint coating on an 08kp steel irradiated with UV rays.

The study of paint coatings composition shows that the EP-773 two-component epoxy enamel coating consists of the pigment, dispersed in a binder, dissolved in a particular solvent. It is visible that Fe content decreases under UV irradiation. It must be assumed that reduction of Fe content indicates decreasing of coatings corrosion due to the formation of uniformly, dense and non-porous paint coatings.

Conclusion

- Based on the results of experiments, the main conclusion is that an addition of Q-cel 6048 hollow glass microspheres into the industrial EP-773 two-component epoxy enamel leads to decrease in a number and extent of microcracks in a volume of paint coatings.
- It is shown that a hardness of the paint coatings increases, while maintaining a high level of adhesion and impact strength. It has been established that hollow glass microspheres improve the hiding power of the paint coatings, thereby contributing to saving paint coats material and increasing the service life of coatings due decreasing of the amount of corrosion products on the surface of paint coatings.

- It is established that the optimal concentration of the hollow glass microspheres in the industrial EP-773 two-component epoxy enamel is 10%. This concentration provides increasing of hardness up to 10-15%, reducing of moisture absorption more than 20% while maintaining a high level of adhesion and impact strength.
- It is obtained that effect of the UV radiation (wavelength 207 nm) on the surface of paint coatings formed from the industrial EP-773 two-component epoxy enamel modified with active fillers leads to structure destruction primarily near microspheres due occurring extra internal stresses and promotes to derivation of polymer crosslinking due to the successive addition of free-radical building blocks.
- The experimental date indicate that UV irradiation of paint coatings formed from the EP-773 two-component epoxy enamel with glass microspheres Q-cel 6048 promotes to formation of uniformly, dense and non-porous paint coatings with decreased hardness but with extra corrosion protection.

Thank you for attention

Contact me

Natalia Valko

N.Valko@grsu.by

Phone (Viber, WhatsApp):+375297841915