

**Table 1.** Properties of nickel coatings obtained from aqueous and non-aqueous solutions

|  |            | Aqueous electrolyte | Non-aqueous electrolyte |
|--|------------|---------------------|-------------------------|
| Microhardness, HV  |            | 483                 | 550                     |
| Porosity, pores on cm <sup>2</sup> (thickness of Ni 6/9/15 μm)                                     |            | 30/19/15            | 28/24/21                |
| Microroughness R <sub>a</sub> ,<br>nm / Maximum height,<br>nm on the surface<br>with dimensions of | 20×20 μm   | 188/1680            | 164/1780                |
|  | 4×4 μm     | 35/310              | 54/470                  |
|  | 0.8×0.8 μm | 19.8/170            | 31.7/282                |

20% higher than in aqueous one and indicates the occurring of the secondary reaction of hydrogen evolution.

Solvent plays a great role in the appearance of electrodeposited nickel coatings. Those obtained from non-aqueous and aqueous bathes have dark grey color and light grey color, respectively. Both solvents allow to obtain uniform coating with good adhesion. Nickel coating deposited from aqueous bath had a lot of small defects in form of pitting. The initiation of pits on the cathode surface can be attributed to the formation of hydrogen bubbles on the cathode surface, which adheres to the surface of the deposit. This, in turn, limits the deposition of metal at that point and the metal deposit continues to grow around it resulting in a pit at the location of the bubble. Due to it is coating is uneven. All the nickel coatings were found to be free from pores and cracks with nearly smooth surfaces.

### References

1. Sharma S.S., Sagara Kazunobu // *International Journal of Green Energy*, 2005.– V.2.– P.1–56.
2. K. Neuróhr, L. Pogány, B.G. Tóth, A. Révész, I. Bakonyi, L. Peter // *Journal of Electrochemical Society*, 2015.– V.162(7).– P.D256–D264.
3. D. Thiemig, A. Bund // *Applied Surface Science*, 2009.– V.255.– P.4164–4170.

## PROPERTIES STUDY OF POLYMERIC PETROLEUM RESINS THAT CONTAIN A NITROGEN GROUP

S.I. Gamzatova, L.A. Mikheeva

The research adviser is Candidate of Chemical Sciences, Associate Professor L.I. Bondaletova

National Research Tomsk Polytechnic University  
634050, Russia, Tomsk, 30 Lenin Avenue, snezhana.gamzatova@gmail.com

Most petrochemical plants generate significant amounts of intermediate products and by-products of refining, which do not find adequate application. Some of the by-products continue to be waste, whereas other could be used as raw stock to obtain new substances and materials. These by-products consist of fraction of liquid pyrolysis products, which are used for production of petroleum polymer resins (PPR<sub>s</sub>).

The EDX analysis revealed that the deposited layer consists of pure Ni. Besides Ni, only Cu was found as a major constituent which belonging to the substrate. XRD analysis revealed stable fcc crystal structure of Ni. AFM analysis showed a surface spotted with relatively large, flat or pyramidal crystals, above a layer of roundish particles with a maximum height 1680 nm suggesting that crystal growth from non-aqueous bath occurs with fast nucleation, followed by a preferential growth on active sites. Changing of solvent strongly modifies the growth characteristics and the crystal habit. On the surface appears sharp grains.

Main properties of nickel coatings obtained from aqueous and non-aqueous solutions are shown in Table.

Kinetic features and properties of nickel coatings were established during electrodeposition from electrolytes with various solvents.

In this work, C<sub>9</sub> fraction and dicyclopentadiene fraction (DPF) are the raw stock for PPR<sub>s</sub>. The fraction C<sub>9</sub> consists of saturated hydrocarbons, such as benzene, toluene, xylene, propylbenzene, ethylbenzene, ethylmethylbenzene and unsaturated hydrocarbons, such as cyclopentadiene, styrene, vinyltoluene, α-methylstyrene, β-methylstyrene, dicyclopentadiene, methyldicyclopentadiene, and indene [1]. DPF fraction also include saturated and

Table 1. Properties of Resins and Resin-Based Coatings

| Sample                         | Adhes-ion, point | Hard-ness, kg | Impact strengt, cm | Flexural strength, mm | Film thick-ness, mkm | Adhes-ion kg/cm <sup>2</sup> | Softening point, °C |
|--------------------------------|------------------|---------------|--------------------|-----------------------|----------------------|------------------------------|---------------------|
| PPR <sub>C<sub>9</sub></sub>   | 1                | 0.2           | 1                  | 20                    | 0                    | 14.96                        | 69                  |
| PPC <sub>DF</sub>              | 2                | 0.2           | 1                  | 16                    | 0                    | 13.46                        | 62                  |
| N-PPR <sub>C<sub>9</sub></sub> | 4                | 0.4           | 1                  | 20                    | 0                    | 10.97                        | does not melt       |
| N-PPR <sub>DF</sub>            | 3                | 0.4           | 1                  | 20                    | 0                    | 13.97                        | does not melt       |

unsaturated components. However, this fraction is enriched dicyclopentadiene (50–56%). PPRs were obtained by catalytic polymerization of unsaturated hydrocarbons of these fractions, using the TiCl<sub>4</sub>-Al(C<sub>2</sub>H<sub>5</sub>)<sub>2</sub>Cl catalyst system. The resins obtained do not contain any functional groups; therefore, resins have low adhesion and low resistance to oxidation by oxygen. In order to get rid of these drawbacks, to improve performance and also to expand fields of application, it is necessary to modify the resins by introducing various functional groups into the molecule.

The goal of this work is the synthesis of modified petroleum polymer resins with a nitrogen-containing group and the study of their properties.

Petroleum polymer resins of C<sub>9</sub> fraction (PPR<sub>C<sub>9</sub></sub>) and dicyclopentadiene fraction (PPR<sub>DF</sub>) and nitrated petroleum polymer resins of C<sub>9</sub> fraction (N-PPR<sub>C<sub>9</sub></sub>) and dicyclopentadiene fraction (N-PPR<sub>DF</sub>) are used in this work as a subject of research.

Synthesis of modified resins is performed with concentrated nitric acid in a solution of xylene. The acid is added dropwise for 20 minutes at a temperature of 40 °C. Afterwards, the temperature is raised to 60 °C and this value is maintained for 3 hours. At the end of the synthesis period, the reaction mixture

is washed with distilled water until neutral and dried at room temperature.

The obtained resins, such as PPR<sub>C<sub>9</sub></sub>, PPR<sub>DF</sub>, N-PPR<sub>DF</sub> and N-PPR<sub>C<sub>9</sub></sub> are used for the production of paints and coatings.

The softening temperature of resins and the characteristics of coatings are studied using standard methods, such as: the lattice-cut method or the method for quantitative determination of adhesion of paints and coatings by pull-off force, the method for determining film strength upon impact, the method for determining film elasticity in bending, the method for determining coating hardness and the ring-and-ball method for determining softening temperature (Table 1).

Coatings are applied to metal plates, preliminarily cleaned of impurities and degreased with acetone by watering [2].

It is common knowledge that initial resins are rather rarely used as independent film-forming agents. The introduction of the polar nitro-group into modified resins did not deteriorate properties of their coatings. Therefore, modified resins can be used to prepare compositions, for example, with bitumen or oxidized vegetable oils.

## References

1. *Volgina T.N., Manankova A.A., Soroka L.S. Laboratny praktikum po promyshlennoj organicheskoy himii. – Tomsk: Izd-vo TPU, 2009. – 92p.*
2. *GOST 8832-76 (ISO 1514-84) Paintwork materials. Methods for formation of paint coating for testing.*