FUNCTIONAL ELECTROPLATED COATINGS

Founded in 1970.

Founder: ***Stanislav Nikolaevich VINOGRADOV****, Doctor of Engineering Sciences, Professor, Honoured Worker of Science and Engineering of the Russian Federation, Honoured Worker of Higher Vocational Education of the Russian Federation.*

The research school began to take shape in 1970, based on the work conducted at the Department of Chemistry headed by ***S. N. Vinogradov***. The original name of the group, Electrochemical Deposition of Palladium Alloys, reflected its initial focus.

Significant contributions to the establishment of the group have been made by ***S. N. Vinogradov***, Doctor of Engineering Sciences, Professor; ***Yu. P. Perelygin***, Doctor of Engineering Sciences, Professor; ***S. Yu. Kireev***, Doctor of Engineering Sciences, Associate Professor; G. N. Maltseva, PhD in Engineering, Associate Professor; S. N. Kireeva, PhD in Engineering, Associate Professor; O. S. Vinogradov, PhD in Engineering, Associate Professor; S. V. Kabanov, PhD in Engineering, Associate Professor; I. G. Kolchugina, PhD in Engineering, Associate Professor; I. V. Rashevskaya, PhD in Engineering, Associate Professor; O. V. Zorkina, PhD in Engineering, Associate Professor; N. A. Vinogradova, PhD in Engineering, Associate Professor; L. V. Naumov, PhD in Engineering, Associate Professor.

After the expansion of its research focus, the group received its current name and has since been headed by ***Yu. P. Perelygin****, Doctor of Engineering Sciences, Professor, Head of the Department of Chemistry.*

Members of the research group: ***S. Yu. Kireev***, Doctor of Engineering Sciences, Associate Professor; S. N. Kireeva, PhD in Engineering, Associate Professor; O. S. Vinogradov, PhD in Engineering, Associate Professor; S. V. Kabanov, PhD in Engineering, Associate Professor; I. G. Kolchugina, PhD in Engineering, Associate Professor; I. V. Rashevskaya, PhD in Engineering, Associate Professor; O. V. Zorkina, PhD in Engineering, Associate Professor.

The research group's main research areas are as follows:

1. Co-deposition of ions at the electrode.
2. Electrochemical deposition of metals and alloys.
3. Study of physical, mechanical, and corrosion properties of electroplated coatings.
4. Environmental aspects of electroplating production.

As part of this research, new high-performance electrolytes have been developed for electrodeposition of indium-based alloys with tin, lead, and cadmium, using both direct and asymmetric alternating current. These alloys are intended for soldering electronic components due to their low melting point of 125-135 °C.

The research group has developed a new electrolyte for the deposition of a palladium-zinc alloy, which exhibits superior properties compared to pure palladium coatings.

The research group has developed new acetate-based electrolytes for the deposition of nickel-based alloys with tungsten and rhodium and studied their physical and mechanical properties. Additionally, lactate-based electrolytes have been developed for the electrodeposition of bismuth, nickel, tin, zinc, and a tin-zinc alloy.

The research group has also developed new devices for measuring contact resistance, wear resistance, antifriction properties, and solderability of electroplated coatings.

Theoretical studies are being conducted to establish mathematical relationships between electrolyte composition, electrolyse parameters, and both the composition and current efficiency of the deposited alloy.

The research group pays significant attention to the development of new technological processes for the recycling of spent solutions and wastewater, which make it possible to obtain commercially valuable products.

The group's members are qualified to conduct expert assessments of both existing and planned electroplating facilities and sections. These assessments cover the equipment used, the composition of solutions and electrolytes, the sequence of technological operations, as well as the efficiency of treatment facilities and the processing of sludge generated from wastewater treatment.

Based on the results of the assessments, recommendations are issued to improve the efficiency of treatment facilities, reduce water consumption at electroplating plants, and decrease atmospheric emissions. Technological processes have been developed for recovering copper, zinc, and nickel from the sludge formed during the treatment of electroplating wastewater.

The research outcomes have been applied at Russian universities and implemented at various enterprises and research organisations in the Penza Region.

Furthermore, research is conducted funded by grants and commissioned by the Ministry of Education and Science of the Russian Federation. The group also carries out contract-based research for enterprises and companies in the city of Penza. The most significant research projects are as follow:

– Project titled *Study and Development of Deposition Technologies for Functional Electroplated Coatings Based on Palladium-Copper and Palladium-Copper-Nickel Alloys Using Unsteady Electrolysis*, funded by the Grant for Fundamental Research in Engineering Sciences (Project Supervisor: ***S. N. Vinogradov***), 2001-2002.

Group members after a meeting on current issues of electrochemistry and microelectronics (2012)

– Project titled *Development of a Computer-Aided Electrodeposition Process System for Alloys of Constant Composition*, funded by the Grant for the Development of Scientific Potential of Higher Education (Project Supervisor: ***S. N. Vinogradov***), 2005.

– Project titled *Development of Theoretical Foundations for Stabilising the Ionic Composition of Electrolyte Using Variable-Valence Metal Salts for Electro-Deposition of Alloys of Constant Composition*, funded under the Fundamental Research in Materials and Chemical Technologies programme by order No. 300 of the Ministry of Education and Science of the Russian Federation (Project Supervisor: ***S. N. Vinogradov***), 2006-2008.

– Contract research project titled *Development of Technology for Applying Metal Coatings on ABS Plastic and Metal Products* under the contract of Penza State University with Hydriatika Ltd., Penza, 2014.

Since 1980, the Penza House of Knowledge has hosted the Annual Scientific and Technical Conference on the Theory and Practice of Metal and Alloy Electroplating.

Since 2009, under the leadership of ***S. Yu. Kireev***, the group has been conducting research in the field of Unsteady Electrolysis, a direction originally initiated by ***S. N. Vinogradov*** and ***Yu. P. Perelygin***. The group conducts research to establish correlation between the waveform of polarising current, the electrolysis mode, and such factors as process rate, coating quality, current efficiency, alloy composition, and the properties of the deposited metal and alloy coatings. Scientific foundations and a methodology for the practical implementation of a new electrolysis mode – potentiostatic pulse electrolysis – have been developed. This mode makes it possible to significantly increase the process rate, to produce metal and alloy coatings with improved and predictable sets of physical and mechanical properties, as well as to form multilayer coatings from a single electrolyte, which substantially enhances their corrosion resistance.

The research group's members actively participate in international research. A partnership agreement on joint research has been concluded with the Jagiellonian University (Poland). The research findings have been published in peer-reviewed journals indexed in Web of Science and Scopus.

The research group has supervised and defended 24 PhD dissertations and 2 Doctor of Sciences dissertations, prepared and published 4 monographs and several training manuals. As of 2019, one PhD dissertation was in preparation, and postgraduate students continued their training under the group's supervision.