DEVELOPMENT OF COMPOSITE COATINGS

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Abstract: Currently, the technology of converting solar energy into heat is well developed, mature and economically competitive.This project uses a quasi-metallurgical method of partial reduction of metals from oxides using solid carbon in a solar furnace to synthesize cermet composite materials. This allows obtaining metal nanoparticles directly from matrix oxides. By changing the carbon concentration, temperature and process time, the concentration of metal nanoparticles and the conditions of the reduction reaction can be changed.
Key words: Nanocomposite metal-ceramic materials (cermets), metal reduction, computer modeling, solar furnace synthesis, X-ray phase analysis, selective absorption coatings, spectral-optical properties, blackness level, selectivity coefficient, heat resistance, vacuum heat sink.

Renewable energy is a domestic resource of any country that has sufficient potential to produce the energy needed to supply all or part of that country. [1] Solar energy is the cheapest and most environmentally friendly form of renewable energy sources (QTEM). [2] The most significant experience has been accumulated in its application. [3]

Due to the increase in the consumption of electricity in the republic, there was a need to increase the production of electricity. [4] The development of solar energy in Uzbekistan will help meet the demand for electricity without burning fossil fuels and thereby reduce greenhouse gas emissions. [5] In addition, solar energy helps to develop the country's industry, create new jobs, increase the level of electricity supply and fight against climate change. [6]

The most researched and prepared areas of solar energy use are:

- converting solar energy directly into electricity using photovoltaic panels;
- solar thermal devices for hot water supply and steam generation for thermodynamic conversion.

Currently, the technology of converting solar energy into heat is well developed, mature and economically competitive. [7]

The use of concentrator systems opened a new direction in solar energy. Thus, solar parabolic-cylindrical concentrators were developed, in the center of which vacuum tubes with a selective absorption coating were used, which made it possible to obtain steam with a temperature of up to 400 °C. This steam temperature is not optimal for turbines. In order for the turbine to operate optimally with an FIK of about 35%, steam must be heated to T = 600 - 700°C. Therefore, it is very important to develop selective absorbing coatings that allow to increase the temperature of steam to 600-700°C. Currently, technical oil is used as a heat carrier, which is heated in a heat sink and then transfers energy to steam in a heat exchanger. The thermophysical properties of the heat carrier are very important. Currently, various coolants with high thermophysical parameters, including nanocomposites, are being developed. [8] The creation of efficient heat sinks means that solar thermal stations can run only on solar energy during the day.

Another area where selective absorption coatings are used is hot water solar collectors. It is known that in Uzbekistan, solar hot water collectors work only in the spring-summer-autumn season. [9]

Increasing the FIK of solar photothermal heating devices is one of the rapidly developing directions of research in the field of solar energy. [10] Materials play a key role in solar energy conversion efficiency. Efficient selective-absorbing coatings allow the creation of vacuum tubes for a new generation of solar collectors that can operate all year round. [11]

The main element of solar photothermal devices is a vacuum heat sink with a selective absorption coating. The efficiency and profitability of the devices largely depends on the value of the selectivity coefficient k = α/ , where α is the integral coefficient of absorption of solar radiation, ε is the integral coefficient of the surface's own radiation. Therefore, the creation of film-forming materials with the highest possible selectivity coefficient is considered the most urgent task. [12]

The most promising materials are multi-component composite systems based on oxide matrices and metal fillers (cermets). [13]

There is very little published data on the optical characteristics of metal oxide films and coatings. Therefore, it is of great interest to study the optical properties of metal-ceramic coatings in which metal particles are dispersed in an oxide phase matrix. [14]

Kermet films are distinguished from other materials by the fact that they have a high transparency in the IR-field of their surface thermal radiation, in a thickness that ensures almost complete absorption of sunlight. [15] The ks value of single-layer pure cermet films on highly reflective metal substrates is comparable to that of known multilayer thin-film coatings and, according to theoretical calculations, may be higher. At high temperatures, cermets are more heat resistant than other materials. [16] The reason for this is that cermet is a metal-ceramic composition in which the metal phase, due to its plasticity, prevents the propagation of microcracks and therefore increases its heat resistance. Optical properties (refractive and absorption indices) of coatings based on cermets can be varied by purposefully selecting the metal-oxide pair (computer modeling) and changing the concentration of the mixture components. Therefore, most of the world's research on high-temperature selective absorption coatings is focused on cermets. [17]

Absorbent coatings based on cermets with high selectivity coefficient and high temperature resistance create a new generation of year-round solar heat receivers with technical steam at 230-250 °C and working body temperature above 400 °C with parabolic-cylindrical concentrator and vacuum allows for the production of solar thermal devices with heat sinks and high-temperature solar power plants. [18]

Two approaches are used to obtain cermet coatings. In the first one, cermet semi-product (zagotovka) obtained by heating (specanie) particles of oxides and metals according to ceramic technology is sprayed. It is difficult to obtain dense, defect-free optical coatings from a material formed by solid-phase heat bonding of a pressed slag. [19] The second approach is based on the separate sputtering of oxides and metal powders from separate vaporizers onto the substrate. This method makes it possible to achieve a high output (vosproizvodimosti) of the optical properties of the coatings, despite the difficulty of obtaining a uniform distribution of the component particles in the coating. [20]

Melt evaporation of composite materials synthesized in a solar oven overcomes the limitations of the presented approaches. Coatings obtained from the synthesized nanocomposite material have improved spectral-optical properties. This is due to the fact that the initial synthesis of the nanocomposite material allows to obtain a given structure, phase composition, and the loss of adsorbed gases in the initial charge. The selective absorption coating obtained from the synthesized material has high density and good adhesion properties.

In our research, we tested the technology of direct synthesis of cermets from metal and oxide powders. The synthesis was carried out in air in a solar furnace. But at high temperatures in the air, depending on the activity and dispersion, the metal powders were strongly oxidized. X-ray phase analysis showed that in most of the synthesized materials the metal phase was mostly oxidized and only traces of metals remained. The process is uncontrollable.

This project uses a quasi-metallurgical method of partial reduction of metals from oxides using solid carbon in a solar furnace to synthesize cermet composite materials. This allows obtaining metal nanoparticles directly from matrix oxides. By changing the carbon concentration, temperature and process time, the concentration of metal nanoparticles and the conditions of the reduction reaction can be changed.

The goal of the project is to synthesize nanocomposite metal-ceramic materials (cermets) by partial reduction of metals from oxides in a solar furnace; research on the temperature dependence of the selectivity coefficient and heat resistance of nanocomposite coatings; to create a laboratory mock-up of a vacuum-sealed solar heat sink.

The works carried out within the framework of this project are considered relevant and economically promising. The successful results of the project allow to localize the production of one of the main elements of solar photothermal heating devices - vacuum selective absorption heat receivers in Uzbekistan.

References:

1. Nematilloevich U. A. Methodology for Developing Professional Competence of Students Using Digital Technologies in Practical Training //Journal of Survey in Fisheries Sciences. – 2023. – T. 10. – №. 2S. – C. 1355-1362.
2. Ubaydullaev A. FORMATION OF STUDENTS'SKILLS IN THE ANALYSIS OF POETIC ARTS //Science and innovation. – 2022. – T. 1. – №. B7. – C. 1185-1189.
3. Ubaydullaev A. To Develop Students' Skills In Analyzing Poetic ARTS //JournalNX. – C. 347-351.
4. Ubaydulloyev A. N., Jo'rayev H. O. Mathcad dasturida algebraik masalalarni yechish //Ta'lim va innovatsion tadqiqotlar" Ilmiy-metodik jurnal. – T. 3. – C. 143-146.
5. Ubaydullayev A. N. TALABALARNING KASBIY KOMPETENTLIGINI RIVOJLANTIRISH USULLARI //Educational Research in Universal Sciences. – 2022. – T. 1. – №. 6. – C. 168-176.
6. Ubaydulloyev A. N. et al. FUNKSIONAL TENGLAMA TUSHUNCHASI VA UNI YECHISHNING SODDA USULLARI //Educational Research in Universal Sciences. – 2024. – T. 3. – №. 3. – C. 21-28.
7. Ubaydulloyev A. N. et al. CHIZIQLI ALGEBRA ELEMENTLARI MATRITSA VA DETERMINANTLARNI HISOBLASH USULLARI //Educational Research in Universal Sciences. – 2024. – T. 3. – №. 3. – C. 15-20.
8. Ubaydulloyev A. N., qizi Ro'ziyeva N. K. PARAMETRGA BOG 'LIQ XOSMAS INTEGRAL TUSHUNCHASI VA ULARNI YECHISH USULLARI //Educational Research in Universal Sciences. – 2024. – T. 3. – №. 1. – C. 232-238.
9. Ubaydulloyev A. N., Rajabov J. M. O. G. L. Stereometriya haqida umumiy tushuncha, stereometriya aksiomalari //Science and Education. – 2024. – T. 5. – №. 2. – C. 20-26.
10. Убайдуллаев А. Н. Нейронные Сети //International Conference on Multidimensional Research and Innovative Technological Analyses. – 2023. – C. 157-160.
11. Убайдуллаев А. Н. ГРАФИЧЕСКАЯ СРЕДА И СИСТЕМА ЕЕ ИСПОЛЬЗОВАНИЯ, ОБОЗНАЧЕНИЕ СИСТЕМ КООРДИНАТ //International Conference on Research Identity, Value and Ethics. – 2023. – C. 343-346.
12. KILICHOV O., UBAYDULLAEV A. N. VESTNIK KRAUNC. FIZIKO-MATEMATICESKIE NAUKI //VESTNIK. – 2022. – T. 39. – №. 2. – C. 32-41.
13. Sh K. O., Ubaydullaev A. N. On one boundary value problem for the fourth-order equation in partial derivatives //Вестник КРАУНЦ. Физико-математические науки. – 2022. – Т. 39. – №. 2. – С. 32-41.
14. Kamolov J. J. et al. Use of paraboloid solar concentrators to reduce heat consumption of residential buildings in the climatic conditions of Uzbekistan //BIO Web of Conferences. – EDP Sciences, 2024. – T. 84. – C. 05019.
15. Jalol o'g K. J. et al. KERMET QOPLAMALI INGICHKA PLASTINKANI ISITISH VA SOVITISH NOSTASIONAR JARAYONNING MATEMATIK MODELINI ISHLAB CHIQISH. – 2023.
16. Jalol o'g'li J. et al. QOPLAMALARNI MIKROSKOPIYA VA RENTGEN-FAZAVIY TAHLIL USULIDA TADQIQ QILISH ANALIZ //Innovative Development in Educational Activities. – 2023. – T. 2. – №. 11. – C. 198-205.
17. Davronov D. E., Temirov S. A., Kamolov J. J. TIBBIYOTDA AXBOROT TEXNOLOGIYALARINI O 'QITISH METODIKASI //Educational Research in Universal Sciences. – 2023. – T. 2. – №. 9. – C. 159-164.

18. Jalol o'g K. J. et al. Moylarni Spektral Tahlil Qilish //Miasto Przyszłości. – 2023. – T. 38. – C. 106-109.
19. Файзиэв Ш. Ш. и др. Композицион қопламаларнинг акс эттириш спектрларини ўлчаш, селективлик коэффициентини аниқлаш //Science and Education. – 2022. – Т. 3. – №. 4. – С. 401-404.
20. Sadikovich N. E. et al. Energy-saving and environmentally friendly technologies for volcanization of elastomeric compositions //Results of National Scientific Research International Journal. – 2022. – T. 1. – №. 2. – C. 101-105.