

sate for the purpose of production commercial gasoline components is most appropriate for the following technological parameters: 1) $T=375\text{ }^{\circ}\text{C}$,

$P=0.25\text{ MPa}, V=3\text{ h}^{-1}$ (Product №4); 2) $T=375\text{ }^{\circ}\text{C}$,
 $P=0.35\text{ MPa}, V=2\text{ h}^{-1}$ (Product №6).

References

1. USS 32513-2013 "Automotive fuels. Unleaded petrol. Specifications".— M.: Standardinform, 2014.— P.16.
2. Altynov A.A., Bogdanov I., Kirgina M.V. Study of the possibility of using stable gas condensate as a component of automobile gasolines //

Problems of Geology and Subsurface Development: Proceedings of the 22th International Scientific Symposium of students, Postgraduates and young Scientists Part II / Tomsk Polytechnic University.— Tomsk: TPU Publishing House, 2018.— P.369–370.

SYNTHESIS OF COMPLEX OXIDES FOR NUCLEAR FUEL IN LOW-TEMPERATURE PLASMA

A.E. Tikhonov

Scientific adviser – assistant lecturer I.Yu. Novoselov

*National Research Tomsk Polytechnic University
634050, Russia, Tomsk, 30 Lenin Avenue, aet13@tpu.ru*

Ceramic nuclear fuel made of uranium dioxide has a number of significant drawbacks: low thermal conductivity, high brittleness, tendency to crack, a rather short cycle of use, and a limited resource of the uranium-235 isotope [1]. This has caused a slowdown in recent years in the development of nuclear energy in a number of countries.

A promising trend today is the creation of dispersion nuclear fuel, which is characterized by the absence of contacts between particles of fissile material due to their uniform distribution in the matrix and has the following advantages: high thermal conductivity and good mechanical properties, more complete fissile material burn, high radiation resistance and strength, localization of fission products in matrix [2].

Common disadvantages of the technologies used to obtain complex oxide compositions from solutions (usually nitric-acid) are: multi-staging, high cost of processing raw materials, inhomogeneous phase distribution, the need to use much chemicals.

At the same time, the technology of synthesis of oxides in air plasma has the following advantages: one-staging, homogeneous distribution of phases with a given stoichiometric composition, the ability to actively influence the size and morphology of particles [3, 4].

It should be noted that the processing of nitric-acid solutions in plasma is quite expensive. To reduce energy consumption, it needs to add any organic component into the solutions, which, when

oxidizing in the air plasma, creates additional energy, allowing to increase the consumption of the processed solution and, thus, increase the yield of the target product.

The work represents carried out thermodynamic modeling of plasmachemical synthesis of complex oxide compositions from water-organic nitrate solutions (WONS), consisting of fissile material (inclusion) and matrix. Uranium dioxide was considered as a fissile inclusion, and magnesium oxide as the matrix material, acetone were used as organic component. The proportion of fuel inclusion in the target complex oxide composition was selected within the range of 95%–85%, the proportion of the matrix within 5%–15%.

Based on the modeling results, the optimal WONS based on uranyl nitrate, magnesium nitrate and acetone were calculated, and the optimal modes (WONS-air ratios) of the WONS plasma treatment were calculated. It was shown that with an excess of air, non-target products (UO_3 , U_3O_8 , U_4O_9) are formed from the initial solutions, with a deficiency of air – products of incomplete thermal decomposition of hydrocarbons in WONS (soot). It was shown that the optimal air fraction varied in the range of 69%–71%.

The results of the studies can be used to calculate the plasmachemical synthesis of complex oxide compositions for dispersion nuclear fuel.

This work was financially supported by the Russian Science Foundation (project 18-19-00136).

References

- Skorov D.M., Bychkov Yu.F., Dashkovsky A.M. *Reactor material science.*—Moscow: Atomizdat, 1979.—344 p.
- Alexeyev S.V., Zaytsev V.A., Tolstoukhov S.S. *Dispersion nuclear fuel.*—Moscow: Tekhnosfera, 2015.—248 p.
- Kosmachev P.V., Vlasov V.A., Skripnikova N.K. // *Russian Physics Journal*, 2017.—V.60.—№2.—P.46–50.
- Novoselov I.Yu., Karengin A.G., Shamanin I.V., Alyukov E.S. *Plasmachemical synthesis of nanosized powders of yttria and zirconia from dispersed water-salt-organic mixtures* // *Polzunovskiy vestnik*, 2017.—V.1.—№3.—P.142–148.

ALKYLATED VERDAZYL AS INITIATORS FOR CONTROLLED/LIVING POLYMERIZATION

D.E. Votkina, P.V. Petunin

Scientific adviser – associate professor, PhD P.S. Postnikov

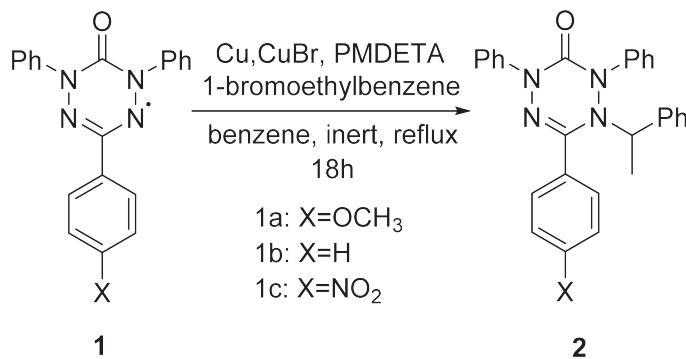
National Research Tomsk Polytechnic University
634050, Russia, Tomsk, 30 Lenin Avenue, dvotkina@mail.ru

Nowadays, the controlled living polymerization has drawn much attraction in the field of preparation and design of novel polymer materials. The widespread applicability of living radical polymerization is explained by the broad opportunities in the preparation of polymers with the precise control of molecular weight and narrow molecular weight distribution. To date, nitroxides are the most effective and well-studied initiators for the initiation of polymerization. They allow synthesizing a polymer with desired properties as well as carrying out the polymerization at mild conditions [1, 2]. At the same time, other types of radicals have been studied poorly that offers opportunities for search new initiators for controlled/living polymerization.

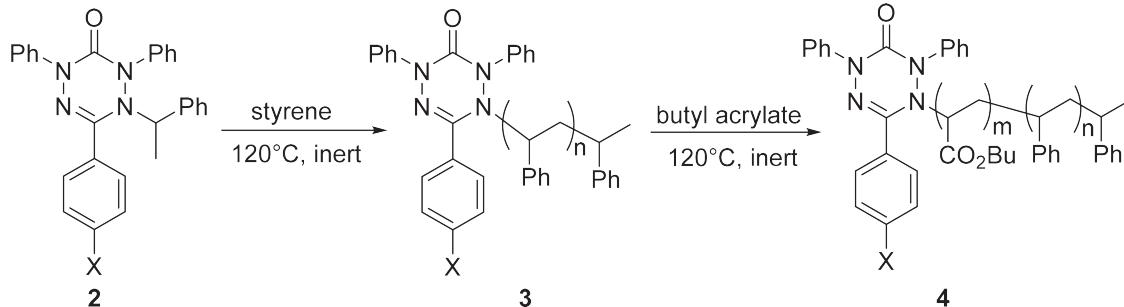
We focused on 6-oxoverdazyls that have the same high stability as nitroxides at storage and during the polymerization process [3]. In addition, the presence of three aromatic substituents in the structure of the molecule allows us to finely tune the properties of initiators by electronic and steric effects influence.

Thus, the aim of this research is the preparation and evaluation of alkylated verdazyl radicals **2** as initiators of controlled living polymerization. First, radicals **1** were synthesized according to our recently developed pathway [4]. Further, alkylated verdazyls **2** with electron-donating and electron-withdrawing groups (scheme 1) were obtained taking into account method of alkoxyamines synthesis [5].

The next step is the implementation of initiators **2a–c** in thermal polymerization of styrene. As a result, it was found that the polymerization is con-



Scheme 1. Synthesis of alkylated 6-oxoverdazyls 2



Scheme 2. Polymerization with initiators 2