

Моя профессиональная
карьера



ISSN

INTERNATIONAL
STANDARD
SERIAL
NUMBER

ISSN

2782-4365

Проверить
номер:



Научно-образовательный электронный журнал

ОБРАЗОВАНИЕ И НАУКА В XXI ВЕКЕ

Выпуск №62-5 (том 1)
(май, 2025)



Проверить индексацию статьи. Сайт: mpcareer.ru/google



Свидетельство
о регистрации СМИ
№ЭЛ ФС 77-77927
от 19.02.2020 г.



РОСКОМНАДЗОР

Периодичность выпуска: 1 раз в неделю

Сайт: mpcareer.ru/oinv21veke. Почта: obrmpcareer@mail.ru



Международный научно-образовательный
электронный журнал
«ОБРАЗОВАНИЕ И НАУКА В XXI ВЕКЕ»

ISSN 2782-4365

УДК 37

ББК 94

**Международный научно-образовательный электронный журнал
«ОБРАЗОВАНИЕ И НАУКА В XXI ВЕКЕ». Выпуск №62-5 (том 1) (май,
2025). Дата выхода в свет: 02.06.2025.**

Сборник содержит научные статьи отечественных и зарубежных авторов по экономическим, техническим, философским, юридическим и другим наукам.

Миссия научно-образовательного электронного журнала «ОБРАЗОВАНИЕ И НАУКА В XXI ВЕКЕ» состоит в поддержке интереса читателей к оригинальным исследованиям и инновационным подходам в различных тематических направлениях, которые способствуют распространению лучшей отечественной и зарубежной практики в интернет пространстве.

Целевая аудитория журнала охватывает работников сферы образования (воспитателей, педагогов, учителей, руководителей кружков) и школьников, интересующихся вопросами, освещаемыми в журнале.

Материалы публикуются в авторской редакции. За соблюдение законов об интеллектуальной собственности и за содержание статей ответственность несут авторы статей. Мнение редакции может не совпадать с мнением авторов статей. При использовании и заимствовании материалов ссылка на издание обязательна.

© ООО «МОЯ ПРОФЕССИОНАЛЬНАЯ КАРЬЕРА»

© Коллектив авторов

Rejepov Rustem, Agayev Rustem DEVELOPMENT OF SUBMARINE TECHNOLOGY USING THE REMOTE-CONTROL UNIT AND RF RECEIVER	59
Satimova Servinaz, Orazmyradova Oguljemal, Ekayev Mukam HYDROTHERMAL SYNTHESIS OF VICTORIA GREEN $\text{Ca}_3\text{Cr}_2\text{Si}_3\text{O}_{12}$ NANOPARTICLES	64
Kervenamanova Gulayym, Bayramova Oguldurdy TECHNOLOGY FOR EXTRACTING SAPONIN FROM PLANTAGO MAJOR	69
Myratdurdyeva Aygozel, Yagmyrova Jennet, Suvhanova Leyli THE DIRECTION OF REGIONAL ECONOMIC COOPERATION TO ENSURE SUSTAINABLE DEVELOPMENT	74
Jennet Babayeva HUMANITIES-BASED APPROACHES TO COMMUNITY DEVELOPMENT	79
Гочыев Бердимырат Джумагулыевич, Алланов Гуванч Чарыярович, Гуйчгелдиева Лачын Гуйчгелдиевна, Бегенджова Энегул Бегенджовна ЗАЩИТА ПРОВОДОВ ВОЗДУШНЫХ ЛИНИЙ ОТ ОБРАЗОВАНИЯ РЕЗОНАНСОВ МЕХАНИЧЕСКИХ НАГРУЗОК	85
Гочыев Бердимырат Джумагулыевич, Ширмаммедов Тойлыныяз Ашырмырадович, Сейидов Мекан Сердарович, Атаева Огулгерек Ахмедовна ПРИМЕНЕНИЕ НАТЯЖНОГО ЗАЖИМА СПИРАЛЬНОГО ТИПА ДЛЯ БОЛЬШИХ ПЕРЕХОДОВ	92
Гочыев Бердимырат Джумагулыевич, Атаева Дияргулы Вепаевич, Ёллыева Тавус Ровшен гызы, Гурбанов Батыр Айдогдыевич РАЗВИТИЕ ПРИМЕНЕНИЕ ЛИНИИ ЭЛЕКТРОПЕРЕДАЧ ПОСТОЯННОГО ТОКА	99
Гочыев Бердимырат Джумагулыевич, Гурбансахедов Максат Чарымырадович, Мередова Шасенем Мердан гызы, Хемраев Довлетгелди Рустамджанович ЗАЩИТА ОТ ВИБРАЦИИ ПРОВОДОВ ВОЗДУШНЫХ ЛИНИЙ В МЕСТАХ ПЕРЕХОДА ЧЕРЕЗ РЕКУ АМУДАРЬЯ	106
Сапарова Огулгерек Нурыгдыевна, Ходжаева Акджагул Худайберди гызы ИЗУЧЕНИЕ ОПЫТА ВЬЕТНАМА В ОБЛАСТИ СОЛНЕЧНОЙ ЭНЕРГЕТИКИ	113
Кудратуллаев Кемал Нурыевич, Аманова Лачын Реджепгелдиевна АТОПИЧЕСКИЙ ДЕРМАТИТ (ЭКЗЕМА): СОВРЕМЕННЫЕ МЕТОДЫ ЛЕЧЕНИЯ	116
Данатарова Мяхри Каисовна ГЛОБАЛИЗАЦИЯ ТЕЛЕМЕДИЦИНЫ: ВЫЗОВЫ, ТЕХНОЛОГИИ И ПЕРСПЕКТИВЫ ИНТЕГРАЦИИ	144

ФИО автора(-ов): *Satimova Servinaz*

*Student, Oguz han Engieneering and technology
university of Turkmenistan*

Orazmyradova Oguljema

*Lecturer, Oguz han Engieneering and technology
university of Turkmenistan*

Ekayev Mukam

*Lecturer, Oguz han Engieneering and technology
university of Turkmenistan*

Название публикации: «HYDROTHERMAL SYNTHESIS OF VICTORIA GREEN $\text{Ca}_3\text{Cr}_2\text{Si}_3\text{O}_{12}$ NANOPARTICLES»

Abstract

This study investigates the hydrothermal synthesis of Victoria green $\text{Ca}_3\text{Cr}_2\text{Si}_3\text{O}_{12}$ nanoparticles, a chromium-based silicate garnet known for its promising optical, catalytic, and environmental applications. The synthesis method explored involves the controlled reaction of calcium nitrate, chromium nitrate, and tetraethyl orthosilicate (TEOS) in an aqueous medium under autogenous pressure at elevated temperatures. Hydrothermal techniques were selected for their ability to yield highly crystalline and phase-pure products at relatively low temperatures compared to conventional solid-state synthesis. The resulting nanoparticles were characterized using X-ray diffraction (XRD), scanning electron microscopy (SEM), and Fourier transform infrared spectroscopy (FTIR). The study demonstrates that hydrothermal conditions enabled the formation of uniform, nanometer-scale Victoria green garnet particles with minimal agglomeration. Crystallinity, purity, and morphology were optimized by adjusting reaction parameters such as pH, temperature, and synthesis duration. These findings contribute to expanding the application of chromium-containing garnets in optical devices, photocatalysis, and green material technologies.

Methods and Methodology

The synthesis of $\text{Ca}_3\text{Cr}_2\text{Si}_3\text{O}_{12}$ nanoparticles was achieved through a hydrothermal process employing aqueous precursors and sealed autoclave reactors. Calcium nitrate tetrahydrate, chromium(III) nitrate nonahydrate, and tetraethyl orthosilicate (TEOS) were used as the sources of Ca^{2+} , Cr^{3+} , and Si^{4+} ions, respectively. Stoichiometric quantities of each precursor were dissolved in deionized water to prepare a homogeneous solution. The pH was adjusted using ammonia to facilitate the hydrolysis of TEOS and stabilize the mixed metal ion solution. The prepared solution was transferred into Teflon-lined stainless steel autoclaves and subjected to hydrothermal treatment at temperatures ranging from 180°C to 220°C for durations of 12 to 48 hours. Post-reaction, the solid products were collected by centrifugation, washed with ethanol and distilled water, and dried at 80°C . Characterization techniques included XRD for phase identification, SEM for morphological analysis, and FTIR for functional group detection. Reaction conditions were systematically varied to study their influence on phase formation, crystallinity, and particle size.

Main Body

The exploration of hydrothermal synthesis routes for the fabrication of nanostructured materials has drawn significant attention in recent years, particularly for complex oxides and silicates. One such material of interest is $\text{Ca}_3\text{Cr}_2\text{Si}_3\text{O}_{12}$, a garnet-type silicate with a distinct green hue, often referred to as Victoria green. This compound belongs to the family of isostructural garnets with the general formula $\text{A}_3\text{B}_2(\text{SiO}_4)_3$, where A and B represent various divalent and trivalent cations. In the case of Victoria green, calcium occupies the A-sites, chromium the B-sites, and silicon resides in the tetrahedral framework. The combination of calcium, chromium, and silicon in garnet structure offers unique optical absorption properties due to the d^3 electron configuration of Cr^{3+} in octahedral coordination.

Traditional methods for synthesizing garnet-type materials often involve high-temperature solid-state reactions, which result in coarse particles and require extensive grinding. These methods also demand significant energy input and yield products with heterogeneous morphologies. In contrast, hydrothermal synthesis offers a low-

temperature, solution-mediated route that promotes crystal growth under thermodynamically favorable conditions. This technique allows for the synthesis of phase-pure and nanoscale materials with controlled morphology and reduced synthesis time.

The preparation of Victoria green nanoparticles began with the selection of suitable precursor compounds that dissolve readily in water and react under hydrothermal conditions. Calcium nitrate tetrahydrate and chromium nitrate nonahydrate were selected due to their solubility and stability in aqueous solution. TEOS, a common silicon source in sol-gel and hydrothermal syntheses, was hydrolyzed in situ by controlling the solution pH with ammonia. The pH played a crucial role in facilitating the condensation of silanol groups and ensuring homogeneity in the metal ion distribution prior to nucleation.

Initial trials employed a reaction temperature of 180°C for 24 hours, resulting in a partially crystalline product with noticeable amorphous content. XRD analysis indicated the presence of minor by-products, including chromium oxides and unreacted silica. To optimize crystallinity and phase purity, the temperature was gradually increased to 200°C and then to 220°C in subsequent experiments. The results showed a clear enhancement in the sharpness and intensity of diffraction peaks corresponding to the garnet structure at higher temperatures. These peaks were indexed to the Ia-3d space group typical of garnet-type compounds.

SEM imaging revealed that lower temperature reactions produced irregularly shaped particles with substantial agglomeration. As the reaction temperature and time were increased, the morphology became more defined, with spherical to polyhedral nanoparticles forming at 220°C after 48 hours. The average particle size ranged between 50 and 100 nm, with some degree of size distribution depending on the aging time of the precursor solution. The washing and drying procedures also influenced the agglomeration tendency, and ethanol rinsing proved effective in reducing surface tension and promoting particle separation.

FTIR spectra supported the formation of silicate frameworks, showing characteristic bands near 1000 cm^{-1} corresponding to Si–O stretching vibrations. The

presence of Cr–O bonds was inferred from weak bands around 600 cm^{-1} , indicative of octahedral chromium coordination. No organic residues were detected, confirming the purity of the final products after post-synthesis cleaning.

An essential aspect of hydrothermal synthesis was the control over nucleation and growth kinetics. Rapid nucleation was encouraged by initially maintaining supersaturation, while slower growth rates led to uniform nanoparticles with fewer defects. The formation mechanism likely involved initial hydrolysis and condensation reactions, followed by the self-assembly of primary particles and subsequent crystallization under elevated temperatures and pressure. The confined environment of the autoclave created a high vapor pressure, enhancing the solubility and reactivity of precursors and driving the formation of the garnet phase.

A comparison between different pH conditions revealed that mildly basic environments (pH 9–10) were optimal for preventing precipitation of hydroxides and promoting homogeneous nucleation. Acidic or strongly basic media led to heterogeneous precipitation and poor crystallinity. Moreover, the addition of surfactants such as polyethylene glycol was investigated as a means to control particle morphology. While surfactants did alter the shape and aggregation behavior, they introduced residual organics that complicated purification, and thus their use was limited in the final synthesis protocol.

The optical properties of the synthesized $\text{Ca}_3\text{Cr}_2\text{Si}_3\text{O}_{12}$ nanoparticles were also examined using UV-Vis diffuse reflectance spectroscopy. The spectra displayed absorption bands around 450–600 nm, consistent with d–d transitions of Cr^{3+} ions in octahedral sites, giving rise to the characteristic green coloration. These optical features indicate potential applications of Victoria green nanoparticles in pigments, photocatalysts, and sensor materials.

In addition to optical applications, chromium-based garnets have shown promise in catalysis and environmental remediation. The high surface area of nanoparticles enhances catalytic activity, while the chemical stability of the garnet structure provides durability under harsh conditions. The present study suggests that hydrothermally

synthesized Victoria green nanoparticles could be utilized in photocatalytic degradation of pollutants or as active components in electrochemical devices.

Thermal stability of the products was evaluated by thermogravimetric analysis (TGA), which confirmed the absence of weight loss above 300°C, indicating that no volatile components remained. Differential scanning calorimetry (DSC) showed a broad endothermic region between 100°C and 150°C corresponding to desorption of physically adsorbed moisture, while no phase transitions were observed up to 800°C, confirming the stability of the crystalline structure.

In conclusion, the hydrothermal synthesis of $\text{Ca}_3\text{Cr}_2\text{Si}_3\text{O}_{12}$ nanoparticles provided an efficient, low-temperature route to produce nanostructured Victoria green garnet with high crystallinity and purity. The reaction parameters, including pH, temperature, time, and washing protocol, significantly influenced the phase formation and morphology. This method offers advantages over conventional techniques and opens pathways for the development of functional materials in optics, catalysis, and environmental technologies. Future work may involve doping studies to further tailor the electronic properties or exploring composite formation with other functional oxides for synergistic performance.

References

1. Durand, M., Lefèvre, P., & Moreau, J. (2021). Synthèse hydrothermale et propriétés optiques des silicates à structure grenat. *Journal Français de Chimie des Matériaux*, 45(2), 85–96.
2. Lambert, S., Rousseau, C., & Girard, F. (2020). Étude structurale de matériaux nano-cristallins obtenus par voie hydrothermale. *Revue des Sciences Matériaux*, 38(3), 211–229.
3. Benoît, A., Charpentier, D., & Lemoine, A. (2022). Nanoparticules fonctionnelles à base de chrome: synthèse, caractérisation et applications. *Bulletin de la Société Française de Chimie*, 159(4), 337