Министерство науки и высшего образования Российской Федерации
федеральное государственное автономное образовательное учреждение
высшего образования

**«НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ
ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ»**

Направление подготовки/профиль: 14.06.01 Ядерная, тепловая и возобновляемая энергетика и сопутствующие технологии, 05.14.03 Ядерные энергетические установки, включая проектирование, эксплуатацию и вывод из эксплуатации
Школа: Инженерная школа ядерных технологий
Отделение: Отделение ядерно-топливного цикла

Научно-квалификационная работа

Тема научного доклада
Разработка технологии нанесения карбида кремния спеканием на циркониевую оболочку топлива для легководных реакторов

УДК _____621.039.577:621.039.54:661.665.1:621.762.5

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Томск – 2022 г

TOMSK POLYTECHNIC UNIVERSITY ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

Министерство науки и высшего образования Российской Федерации
федеральное государственное автономное
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«Национальный исследовательский Томский политехнический университет» (ТПУ)

Field of training (specialty): 14.06.01 Nuclear, Thermal and Renewable Energy and Related Technologies, 05.14.03 Nuclear Power Plants: Design, Operation and Decommissioning.
School: Nuclear Science & Engineering
Division: Nuclear Fuel Cycle

Scientific qualification work

Topic
Development Of Technologies of Sintered Silicon Carbide on Zirconium-Alloys for LWRs Fuel Cladding Design

UDC _____621.039.577:621.039.54:661.665.1:621.762.5

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Tomsk – 2022

Annotation

The PhD dissertation contains an introduction, 5 chapters, concluding remarks, 256 references and appendices. In total, the dissertation has 156 pages, 57 figures and 16 tables.

Keywords: Silicon carbide, zirconium, selective laser sintering, mechanical properties, scratch adhesion, micro-indentation, wear tribology, non-destructive testing, ultrasound testing, eddy current testing, neutronics, high-temperature oxidation, mass-gained and surface modification.

The main aim of the dissertation is directed towards improving the existing and future LWR's fuel cladding in order to improve the cladding safety, efficiency, and cladding integrity through surface modification of nuclear grade Zr-alloy with SiC composites films.

The research is centered on establishing a solid foundation for further investigations towards designing a robust cladding material for replacing existing and some future Light Water Reactor fuel cladding components.

SiC micro-composites were deposited on substrates with IPG Photonics laser sintering set-up. High temperature oxidation investigations on samples at 1200 ^{0}C for 600 s were performed with the ITM furnace setup. Also, macro-scratch adhesion, wear tribological and micro-indentation mechanical investigations were performed on samples with Rockwell diamond cone indenter, Anton Paar TRB^{3} tribometer ball-on-disk sliding setup and KB Hardwin XL indentation setup equipped with the Vickers pyramid indenter respectively.

The results presented in the dissertation were thoroughly investigated with acceptable, highly recognized scientific and mathematical formulations, processing and analyzing deterministic softwares. Notable software and programs such as the Sleve+ program, Crystallographica SearchMatch, PowderCell, SEM, EDS, MATLAB, OriginLab, SuperMC and other advanced data processing analyzing programs were involved.

The results were thoroughly reviewed, accepted and published by high-ranking journals indexed in Scopus and web of science academic databases. The obtained results provide promising outcomes to ensuring the continuity of the research towards the stated goal.

In summary, surface modification of zirconium-alloys with silicon carbide micro-composites shows promising alternative to enhancing the existing and future fuel cladding components for Light Water Reactors. Further studies in the direction of the research were also proposed.