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Abstracts book

2th - 6th June 2025
Kharkiv, Ukraine (Online)

CM&LTP 2025 | Kharkiv, Ukraine

B. Verkin ILTPE of NASU

V International Conference
Condensed Matter and Low Temperature Physics
CM&LTP 2025

Book of abstracts

Kharkiv, B. Verkin ILTPE of NASU, 2025

UDK 538.9
H 88

Hurova D.E., Dolbin A.V., Shevchenko S.N. (editors) V International Conference "Condensed Matter and Low Temperature Physics" 2025. Book of abstracts. – Kharkiv: B. Verkin ILTPE of NASU, 2025. – 294 p.

ISBN 978-617-95455-9-7

This book collects 228 peer-reviewed reports presented at the V International Conference "Condensed Matter and Low Temperature Physics" 2025. These materials present the studies of modern aspects of condensed matter and low temperature physics including electronic properties of conducting and superconducting systems, magnetism and magnetic materials, optics, photonics and optical spectroscopy, quantum liquids and quantum crystals, cryocrystals, nanophysics and nanotechnologies, biophysics and physics of macromolecules, materials science, theory of condensed matter physics, technological peculiarities of the instrumentation for physical experiments, and related fields.

The book will be useful to undergraduate, postgraduate students, and researchers in the field of condensed matter physics.

Ця книга зібрала 228 доповідей, представлених на V Міжнародній конференції "Condensed Matter and Low Temperature Physics" 2025 року. Дані матеріали представляють дослідження у галузі сучасних аспектів фізики конденсованого середовища та низьких температур, у тому числі електронні властивості провідних та надпровідних систем, магнетизм, оптику, фотоніку та оптичну спектроскопію, квантові рідини та квантові кристали, кріокристали, нанофізику та нанотехнології, біофізику та фізику макромолекул, матеріалознавство, теорію фізики конденсованих середовищ, технологічні особливості обладнгання для фізичних експериментів та суміжні галузі.

Книга призначена для студентів, аспірантів та дослідників у галузі фізики конденсованого стану.

Recommended to publish by Scientific Council of B. Verkin Institute for Low Temperature Physics and Engineering of the National Academy of Sciences of Ukraine (protocol № 5, 16.04.2025)

Published by B. Verkin ILTPE of NASU
ISBN 978-617-95455-9-7

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Prediction of isomorphous substitutions of strontium or barium by sodium and actinides for their immobilization in molybdates with a scheelite-type structure

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Researchers are interested in solid solutions of the form $M^{II}_{1-x}(M^{I}_{0.5}An_{0.5})_xMoO_4$, where M^{II} is an alkaline earth metal, M^{I} is an alkali metal, and An is an actinide, due to their potential practical application in the immobilization of radioactive waste. In this study, within the framework of the crystal energy theory of isomorphous substitutions, the mixing energies (interaction parameters), critical decomposition (stability) temperatures, and isomorphous substitution limits were calculated, and the thermodynamic stability of $Sr_{1-x}(Na_{0.5}An_{0.5})_xMoO_4$ solid solutions was evaluated.

It has been shown that with an increase in the actinide atomic number, the mixing energies and critical decomposition temperatures of the solid solutions systematically increase, primarily due to the growing size parameter, which results from the increasing differences in the sizes of the substituting structural units. A thermodynamic stability diagram and decomposition domes of the solid solutions are presented for concentrations ranging from $x = 0$ to $x = 1.0$ in increments of $x = 0.05$. The diagrams allow for graphical determination of the decomposition temperature for a given composition, the equilibrium substitution limit at a given temperature, and the assessment of thermodynamic stability ranges. It has been established that substitution in the $Ba_{1-x}(Na_{0.5}An_{0.5})_xMoO_4$ systems follows our previously formulated second rule of isomorphous substitution polarity: the decomposition temperature is higher for the component with the smaller substituting structural unit.

Under the temperature conditions recommended by the IAEA for radioactive waste disposal (373 K or lower), continuous solid solution series of $Sr_{1-x}(Na_{0.5}An_{0.5})_xMoO_4$ are thermodynamically stable in the case of actinides from the Ac–Pu series. However, these solid solutions will either decompose or become metastable under such conditions for actinides from the Am–No series.

Lanthanides from the La–Gd series can serve as actinide simulants, as the critical decomposition temperatures of their solid solutions differ only slightly (~100–200 K) from those of the corresponding actinide-containing solid solutions. However, their use as simulants is unlikely due to the significantly larger difference (~200–400 K) in the decomposition temperatures of solid solutions involving heavy actinides compared to those with lanthanides (see Fig. 1).

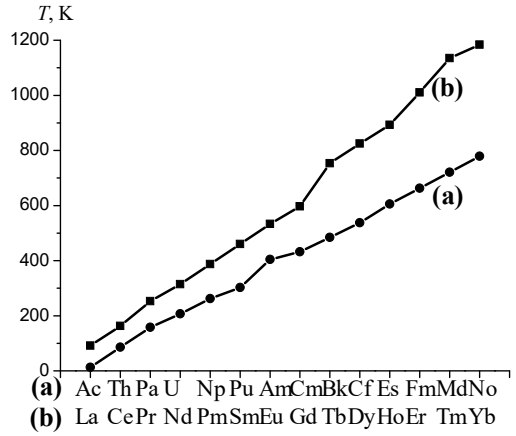

Figure 1 – Dependences of the critical decomposition temperatures of $Sr_{1-x}(Na_{0.5}An_{0.5})_xMoO_4$ (a) and $Sr_{1-x}(Na_{0.5}Ln_{0.5})_xMoO_4$ (b) on the atomic number of actinides and lanthanides.