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Far Eastern Federal University Laboratory of Nuclear Technologies: scientific directions in the development of new functional materials and composites

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主要研究方向为：SPS 烧结技术、陶瓷焊接，以及超高温陶瓷、放射性核废料放置用陶瓷、生物多孔材料等的制备和性能研究等。

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Abstract

The report presented conducts a comprehensive analysis of the current state and future potential of electro-physical sintering (EPS) techniques as a solution to the urgent scientific and technical challenge of producing functional ceramic materials with predetermined characteristics.

In the introduction, the author sequentially classifies the known varieties of EPS methods according to the type of electric current used to consolidate powder materials. It is noted that the Spark Plasma Sintering (SPS) method, which uses high-density pulsed current, has gained the most widespread use in research practice and applied development.

The SPS technique employs high-density pulsed electric current to pass through a die along with the powder material. This causes several phenomena, such as local heating, electric discharges, and plasma effects on the particle surface. These factors promote efficient consolidation at relatively low temperatures.

Furthermore, the author examines the significant disparities between EPS technology and conventional powder metallurgy techniques in detail. Such distinctions consist of: heating is performed not through external heating elements but by directly passing electric current through the die and the sample; volumetric and uniform electric heating of the material; and the formation of a distinct complex of physicochemical processes during EPS that considerably influences the consolidation kinetics and properties of the product.

The SPS technology displays several crucial advantages in comparison to conventional sintering methods. These consist of the potential to conduct sintering at less extreme temperature-time regimes, fast heating and cooling, excellent regulation of the material's microstructure, achieving high density and maintaining porosity. Consequently, this enables efficient sintering of refractory, thermally unstable, and sturdy alloys while generating ceramics and composites possessing exceptional characteristics.

Furthermore, this presentation provides a thorough analysis of the characteristics of compaction and consolidation mechanisms in powder dispersed systems under EPS conditions. Through a review of literature, it is demonstrated that localized heating in the contact areas of individual particles stimulates their surface, initiating an accelerated diffusion and plastic deformation process, ultimately resulting in the development of robust interparticle bonds and system consolidation.

Due to its advantages, SPS technology is seen as a promising direction for the development of EPS methods. Ongoing efforts are being made to create experimental and industrial SPS setups, enhance their functionality, and automate processes. The widespread use of this methodology will greatly aid in the development of new generations of functional ceramics with a predefined complex of properties.

Furthermore, the author examines particular structural characteristics of ceramic materials manufactured via EPS technology, involving the creation of compact ceramic frameworks whilst preserving a developed system of pores in a range of dimensions.

In the presentation, specific examples of the successful application of EPS methods, and in particular SPS technology, to the synthesis of various classes of promising functional ceramics, including bioceramics, nuclear ceramics, high-temperature ceramics, magnetic ceramics, optical ceramics, etc. will be given.

Thus, this presentation provides a comprehensive overview of the present status of EPS techniques, their technical potential and limitations, potential applications in solving practical issues in ceramics production with a distinctive array of physicochemical and operational characteristics, as well as sets out the primary pathways for further development of this promising technology for consolidating dispersed materials.