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Review on the Doctor of Science habilitation thesis

In specialty 05.02.01, Materials Science at Institute for Problems in Materials Science, NAS of Ukraine, Kyiv, 2018 with the title: "***Features of consolidation, formation of the structure and properties of ceramic materials in the processes of spark-plasma sintering***" (manuscript) by **Borodianska Hanna Yu.**

For many materials there is the necessity to obtain high densities and controlled microstructures for further properties enhancement or optimization depending on targeted applications. This is not a trivial problem. Search of new processing routes and understanding of the processes considering also the specifics of the involved materials is the key for success and the interest of materials science community in this direction is high.

Among the advanced processing techniques, spark plasma sintering (SPS) is gaining much recognition as a powerful and versatile method for fabrication of dense materials, often with outstanding properties not matched by similar materials obtained by other methods. Specific features of SPS recommend it as an unconventional method capable to promote activation processes at the surface of the granular particles involved in the consolidation. Although unconventional processes are debated they deserve attention since they can promote formation of novel materials. In the last years, physics of the interfaces and nano structuring have shown new effects with potential for applications. To obtain materials with nano features, effective synthesis/processing routes are needed and SPS can play an important role. Exploration and innovation of SPS is rewarding and DSc thesis by H. Borodianska presents excellent examples and results. Work also propose new composite materials, it combines in some cases SPS with other technologies and it shows some material and technology design solutions for properties control.

Work concerns with different aspects of technological know-how, fundamental physical-chemical processes/reactions that occur during SPS depending on materials, complex relationships between materials, processing and properties, sintering aspects, and kinetics. The work has a two-fold dimension:

(i) On the one side there is the desire to obtain materials with controlled and improved properties by SPS and

(ii) on the other side, SPS processes are observed on selected materials when certain special conditions are used.

In the first category (i), approached materials are oxides, nitrides, borides and carbides. Some of them are targeted as electrolytes for solid oxide fuel cells, while the rest are hard and refractor structural materials. Proposed SPS technological solutions are shown to allow fabrication of these materials with excellent properties and/or they show novel complex but controlled nano/micro structures.

In the second category (ii) the aim is to explore, understand and develop new possibilities of SPS. Through these investigations the range of SPS applicability is expanded and new directions of research are defined. I mention studies pioneering flash regime in SPS and use of SPS for long dwell times and low temperatures favorable to a diffusion controlled process. It is worthy to observe that the later study is opposite to the general trend of research that prizes SPS for being a fast consolidation technique. Studies are not only positioned at extremes of SPS, i.e. for very short or very long processing times, but also attempt to compare SPS with conventional and microwave sintering.

Presented arguments indicate on the high quality and value of the habilitation thesis, which covers 37 ISI articles published in international and well-established scientific journals of high reputation. Work is modern, has perspective, provides new processing solutions for different materials, and proposes interesting materials concepts. It shows fabrication of materials with improved and controlled properties useful for practical applications and explores innovative routes of SPS use.

In summary, DSc habilitation thesis by H. Borodianska fulfills without doubt the conditions to be awarded the degree of Doctor of Science in the specialty 05.02.01 – 'Materials Science'.

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