NOMATEN Seminar

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Tuesday, April 6th 2021, 13:00-15:00

Speaker:
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Title:
Materials sintering and consolidation methods

Abstract:

Issues related to the design and manufacturing of new materials are a driving force behind the development of the modern world. Using the available materials in their natural form would significantly limit the possibility of their use in modern practical solutions. Therefore, progress has been observed for years in the area of miniaturization, strictly connected to the manufacturing and use of new material solutions. Composite materials are a particularly important group of materials, including metal-ceramic composites. By definition, a "composite" is a manufactured (not occurring in the natural environment) material, consisting of at least two components separated by a clear phase boundary, distributed in a controlled manner throughout the entire volume, with unique properties compared to the properties of its separate components. In industrial practice, many examples of composite material use can be found, as structural elements e.g. airplane engine blades, brake discs, aircraft hull plating, combustion engine elements (valves, pistons), chamber lining of combustion chambers in industrial furnaces etc.

The properties of metal-ceramic composite materials depend on the type of matrix material and its share in volume, and primarily on the type, form, size, orientation and distribution method of the reinforcing phase in the composite. Equally important is the type and quality of the connection between the metal and the ceramic (the so-called interface).

One of the most popular method for obtaining of composite materials is sintering of powders. Sintering is a thermal process whose purpose is to connect loose dust particles into a coherent structure, as a result of mass transfer mechanisms, usually occurring on the atomic scale; sintering of particles leads to an increase in strength and a decrease in free energy of the studied system. Sintering is thus a complex physical and chemical process, thermally activated, that occurs at high temperatures. In the case of sintering one-phase materials, there is a definite number of factors impacting the sintering process. Their number and the

complexity of their impact on the process is significantly higher for multi-phase materials. Learning and understanding the relationship between the phenomena accompanying sintering with its effects is incredibly valuable knowledge that makes designing advanced materials possible.

Three groups of factors can be distinguished, thanks to which it is possible to control in terms of the optimization of the structure and properties of composite materials. The first group concerns the influence of factors related to the morphology of the components constituting the starting material in order to obtain composite materials. These can include: the amount, shape, type and form (powders, fibers) of the reinforcing phase, as well as the size of the materials used and their surface area. Another group of factors is related to the method and technological parametres of the process of obtaining composite materials. In the case of powder metallurgy, the one used the most often to create composites, a number of methods can be listed: free sintering, sintering under pressure, sintering with the use of isostatic pressure, Spark Plasma Sintering, hot extrusion etc. The third group of factors is related to the introduction of additional materials into the composite. In this case, it's possible to introduce additives into the matrix or modify the surface of the reinforcing phase. Such actions should result in a stronger material or an improved connection on the metal-ceramic boundary.

The most important results of the research presented, concerning the impact of the particular factors that allow control over the properties, for selected examples of metal-ceramic composite materials will be presented.

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He is a graduate of the Warsaw University of Technology. Scientist with 20 years of experience in the area of Materials Engineering. Head of the Department of Composite and Ceramic Materials in Łukasiewicz Research Network Institute of Microelectronics and Photonics, specializing in the manufacturing and characterization of multiphase materials. Manager and contractor of over 25 research projects, including international ones, in the field of basic research and research and development works. Author of over 70 scientific publications from the JCR list.