From Davis to Dijon: a success story for the SPS technology.

Naimi Foad[1], Bernard Frédéric[2]

1. SINTERMAT – 7 rue Alapetite, Montbard, France

2. ICB – UMR 6303 CNRS / Université de Bourgogne Franche-Comté, Dijon France

Highlights

- From basic research to applications
- Development of a know-how on the sintering by SPS of large parts
- Creation of SPS Company for the production of small and medium series.

1. Introduction

This story around the SPS technology began in 1998 at the University of Davis in the FACS laboratory managed by Prof. Z. Munir. The initial idea was to combine an electric field activation of a self-sustaining reaction and a mechanical activation of powder mixtures to produce dense nanostructured materials. A patent for the synthesis by reactive sintering of dense intermetallic compounds such as $MoSi_2$ and FeAl has been deposited [1]. This collaboration has been very successful since it has enabled many students from Dijon to work at Davis and, thus promote the SPS technology through many scientific articles and Ph-D thesis These different success complemented by works carried out in collaboration with the Prof. Y. Grin (Max Planck Institute, Dresden) have enabled us to acquire a machine SPS (HPD 125 FCT system) in 2009. As well, such collaboration has resulted to highlight the interest of developing the SPS technology for producing dense materials with a finer microstructure through many R&D programs funded by ANR, DGA or by industrial partners. Additionally, many Ph-D theses have enabled notable advances in the understanding of this process in order to control the critical stages from the powder to massive part. In parallel to this fundamental research, we have had the opportunity to create “a Flash Sintering” platform within the University of Burgundy. This reactive structure has for objective to respond to the industrial needs by innovation "Process / Materials". This effort has recently been rewarded by the creation of SINTERMAT spin-off by Dr. F. Naimi [2].

2. Methods

The SPS technology which is a flexible technique involves the sintering under load of different kind of powders. Its potential lies in the production of dense parts with a microstructure perfectly controlled for emerging markets. The different parts sintered that can be obtained are composed of metals and alloys, ceramics, composites and, more recently, of natural materials in partnership with AUTHENTIC MATERIAL [3] issued from the CEMES-CNRS Laboratory. The objective will be to raise the technical risks in link with the reproducibility during SPS and for its industrialization.

3. Results and discussion

The envisaged production is to achieve, via the SPS technology, the sintering of different powders and this, in a desire to increase the capacity of production "to equal quality" to go to a step of the industrialization. Thus, SINTERMAT is committed to meet challenges such as:

- From the realization of small parts (D10 to D60mm) to the manufacture large homogeneous parts (D60 to D300mm),
- From the unit production to the production in series (small and medium),
- From the simple form (discs, cylinders, plates, …) to the complex form,
- From the sintering of advanced materials (metals, ceramics) to the sintering of green materials.

For this last application SINTERMAT has validated the proof of concept to sinter large samples starting from different "natural" material powders produced by AUTHENTIC MATERIAL. Various tests have allowed producing parts replying to the specification of the luxury industry (art of the table, eyewear, and packaging). The need to link with this phase requires the passage to the industrial stage. The innovative character of this approach resides (i) in the fact to develop new applications of technology SPS to reach of sintered materials with improved properties, (ii) in the choice of an eco-responsible approach, materials from technologies "green" since the sintered powders are derived from products often destined for destruction and (iii) to optimize the chain of production, of adapted products to the manufacturing process according to the "just need" thanks to the forms and dimensions customizable.

4. Conclusions

This way consists to position the project on the production and the industrial development of innovative advanced solutions totally based on the Powder Metallurgy techniques. The first surveys and investigations in an industrial environment confirm that this type of project responds to a growing demand to end-users in regard to a research for new solution of materials. In particular, the materials having a controlled microstructure are a promising route and a potential to respond to the expectations. In conclusion, SINTERMAT will respond to the needs of industry in terms of production of small and medium-sized series in emerging markets such as the luxury, defense, aeronautics and energy.

References

[1] US Patent N°6 200 515 B1 – 13 Mars 2001 - « One-step Synthesis and Consolidation of Nano-phase Materials », Z.A. Munir (Université de Californie, Davis) E. Gaffet (UMR 5060 CNRS- UTBM Sévenans), F.Charlot and F. Bernard (LRRS – UMR 5613 CNRS - Université de Bourgogne).
[2] https://www.sinter-mat.com/
[3] https://authentic-material.com/