SPS

Spark Plasma Sintering

MATERIALS & SURFACE SCIENCE INSTITUTE

Introduction

The spark plasma sintering instrument (SPS) (DR. SINTER LAB Model: SPS-515S from SPS SYNTEX INC.) is the first of its type to be installed in Ireland and the U.K. SPS enables sintering of not just all forms of conventional powdered metals, but most forms of ceramics, polymer-metal composites and porous materials. Additionally, this technology is capable of sintering similar and functionally-graded materials, seamless bonding, and material surface treatment.

SPS technology does not require binders or a pre-sintering stage. In the SPS process, the starting powder material is first compressed in a hydraulic press. Power is then applied by using a DC pulse generator which results in neck formation between particles and provides compacted materials with controlled density and high dimensional accuracy and uniformity.

The SPS system operates over a wide temperature range up to a maximum of 2300ºC. In addition, the system has functions to aid in development of a broad spectrum of experimental research on new materials.

SPS systems offer many advantages over conventional sintering systems, including
- Precision control pressure, heating, and cooling
- Rapid and uniform sintering
- Low temperature and short dual time sintering
- Single press-full density compaction
- Low operating costs
- Easy operation
- Sintering under atmospheric conditions, with inert gases or in vacuum

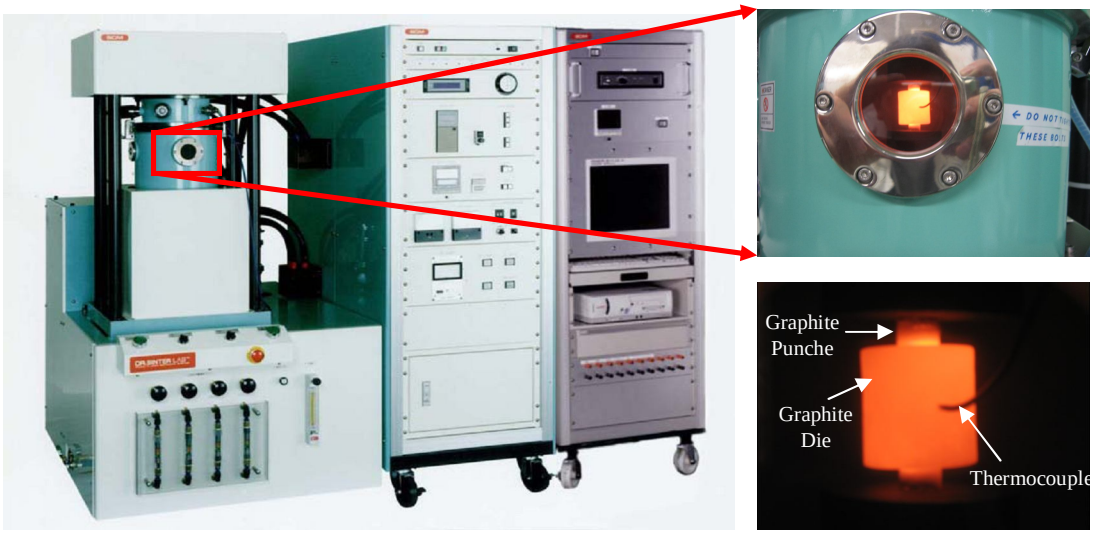

Figure 1. Spark Plasma Sintering (SPS-515S) System

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Technical Specifications:

- Sintering DC pulse generator with On time 1 to 99 digit, Off time 1 to 9 digit
- DC pulse input of 20 V, 1,500 Amp
- Output voltage range from 2 to 20 V and current range from 0 to 1500 Amp
- Sintering time from 0 to 99 min and 59 sec
- Sintering Pressure from 5 to 50 kN (510 to 5100 kgf)
- Operating temperature of 2,200 °C (working temperature) and 2,400 °C (max. temperature) of the chamber.
- Sintering under ambient air, vacuum or inert gas (argon gas ≥ 1800 °C)
- Temperature detectors
    - Low temperature range (up to 1000 °C): Thermocouple
    - High temperature range (600 °C to 3000 °C): Digital radiation thermometer
- Sintering of 10, 15, 20 mm sample diameters

Examples of Sintering Work Undertaken at UL

High sintering temperature (>1200 °C):

Figure 2. Tungsten carbide (WC) pellet sintered at 1800℃ with 50 MPa pressure using SPS

Figure 3. Silicon Nitride (Si_3N_4) pellet prepared at 1600℃ with 20 MPa pressure using SPS

Low sintering temperature (<1200 °C):

Figure 4. Hydroxyapatite(HAp) ceramics can be prepared by SPS in the range 700℃ to 1100℃ with 50 MPa pressure in two minutes .

Figure 5. NiTi shape memory alloy can be sintered between 700℃ to 900℃ with 50 MPa pressure by SPS in two minutes

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