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### Hybrid sintering – The beneficial combination of sintering principles

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# **Hybrid Sintering**



## **The Beneficial Combination of Sintering Principles**

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"FAST/Hybrid" is the trendsetter in hybrid sintering, complementing the conventional hot pressing ("HP") by an additional pulsed current direct heating of the powder compact ("FAST/SPS"). This combination allows a further improvement of heating rates and thermal homogeneity compared to conventional hot pressing, but even superior to the characteristic advantages of the FAST/SPS technique. A high-voltage supply combined with a special pressing tool configuration makes flash sintering ("FAST/Flash") possible, too.



Principle of **FAST/Hybrid**, combining Internal + External Heating. Perfect temperature balance by independent temperature controls.

**FAST/Hybrid** consolidation of Ø 200 mm Titanium MMC disc to full density.





FAST/SPS made the development of highest quality sputtering targets for TCO (transparent conductive oxides) possible. Only by FAST/Hybrid the upscaling to large diameter with the same superior microstructural homogeneity, full density and optimal electrical conductivity succeeded.







courtesy of EU project "Charme" TPS tile







2 3 4 5 6 7 8 9 10 11 12 13 14 12

UHT-CMC parts made by FAST/SPS. Again FAST/Hybrid is an essential prerequisite of upscaling to larger parts.









Long-life cutting tools made of Al2O3-TiC-SiC<sub>w</sub>

Electrical conductive ceramic composite materials for EDM machining made by FAST/SPS. Upscaling by application of FAST/Hybrid is in progress.





ZrB<sub>2</sub>/fiber UHT-CMC made by FAST/SPS











Al2O3-TiC-SiC<sub>w</sub>, Ø 150 mm

Example of high-precision EDM









Early demonstration of the system performance: Pure Tungsten Carbide disc Ø 400 mm consolidated at 2100°C to full density

FAST/Hybrid system operating at

Nanoker Research S.L. in the production

of ceramic and powder-metallic parts.

High-Performance

Charging sector (front view)

FCT Systeme GmbH

#### Thinking "Hybrid Sintering" in a more general way

"Hybrid Sintering" is a beneficial combination of different sintering principles, e.g.

- direct + indirect heating,
- uniaxial + gas pressure,
- high + low electric fields.

Hybrid sintering systems enable the development and production of all new materials.

	ACTIVE SINTERING PRINCIPLES			
FCT Sintering Technology	<b>\\</b> □\\ HEAT	GAS PRESSURE	MECH. PRESSURE	<b> D -</b> Electr. Field
PRESSURELESS	0			
GAS PRESSURE (SINTER) - HIP	0	0		
HOT PRESSING	0		0	
FAST/SPS	$\bigcirc$		0	0
FAST/Hybrid (FAST/Flash)	0		0	0
Hybrid Sintering	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$

A further example of "Hybrid Sintering" is this combination of gas pressure sintering ("GPS" – "Sinter-HIP") and hot pressing ("HP"). Optionally flash sintering ("FAST/Flash") can be Implemented.