Die steel-based powder for printing large products

【DAP™-AM Series LTX】

Characteristics：

- Reduces internal strain during molding compared to H13 and DAP™-AM HTC, suitable for large-sized products(exceeding 150mm square).
- Thermal conductivity is equivalent to SKD61. Mold performance is expected to be similar.
- Co is not contained.

Table1
Typical chemical composition for DAP™-AM LTX.

C	Si	Ni	Cr	Mo	V
0.25	0.1	6	5.2	1.2	0.4

（mass%）

Particle size（μm）
-53/+25

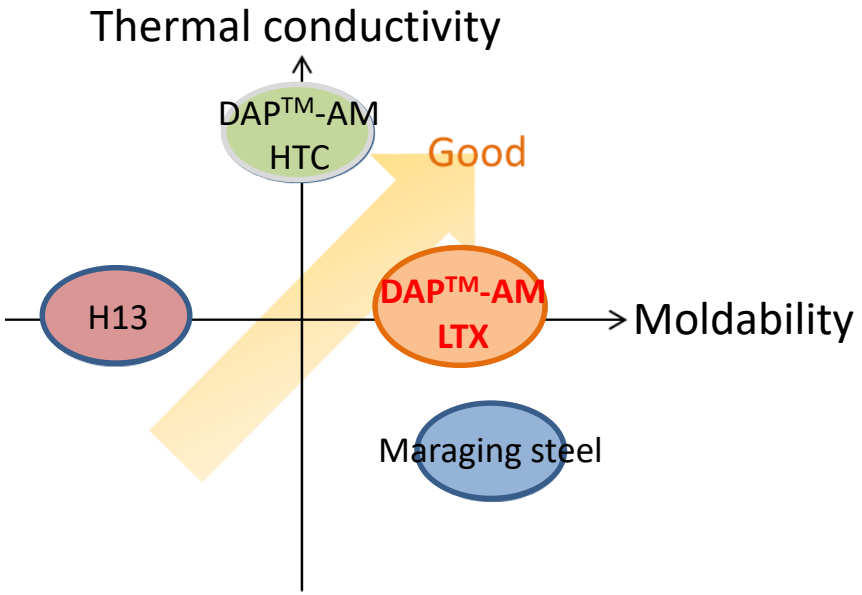
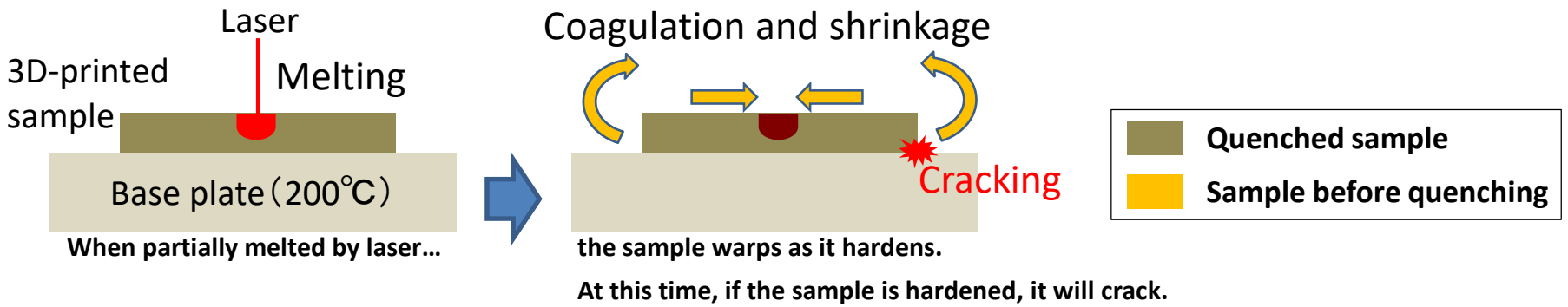


Fig.1 Characteristics of DAP™-AM LTX compared to other powders.

Why does internal strain remain low?

By designing alloys with a martensitic transformation starting temperature (the temperature at which they become hardened by quenching) lower than the molding temperature, the material is not quenched during the molding process, and is soft and less prone to distortion accumulation.
After the molding process is completed, the entire molding part is simultaneously quenched and hardened.

SKD61, DAP™-AM HTC：Hardening starts between 300℃ and 400℃ after quenching.



DAP™-AM LTX：Hardening starts at 200℃ after quenching.

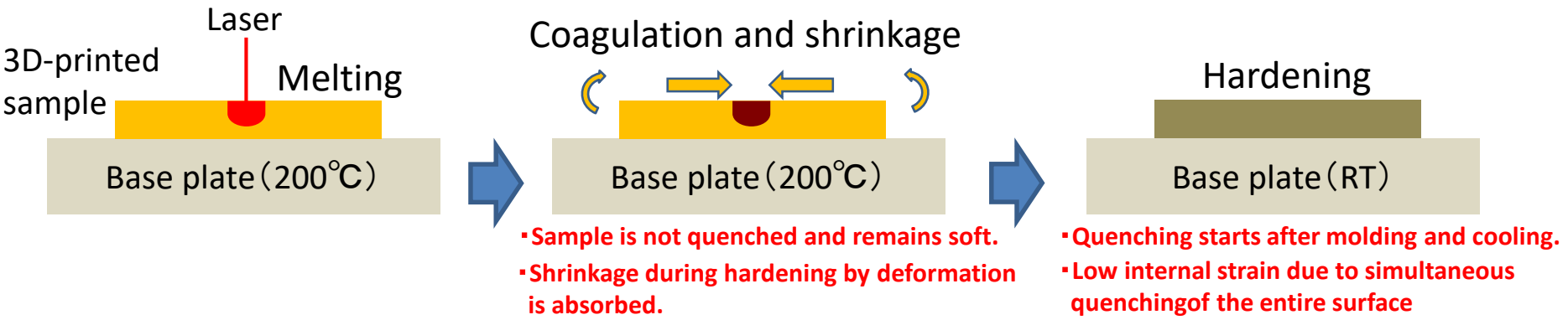


Fig.2 Strain improvement mechanism of DAP™-AM LTX.

Influence of internal strain on base plate temperature

Stable low strain can be obtained by heating the base plate to 160℃ or higher.
If heating to 160℃ or higher is impossible, adjust the temperature around 50℃ to reduce strain.

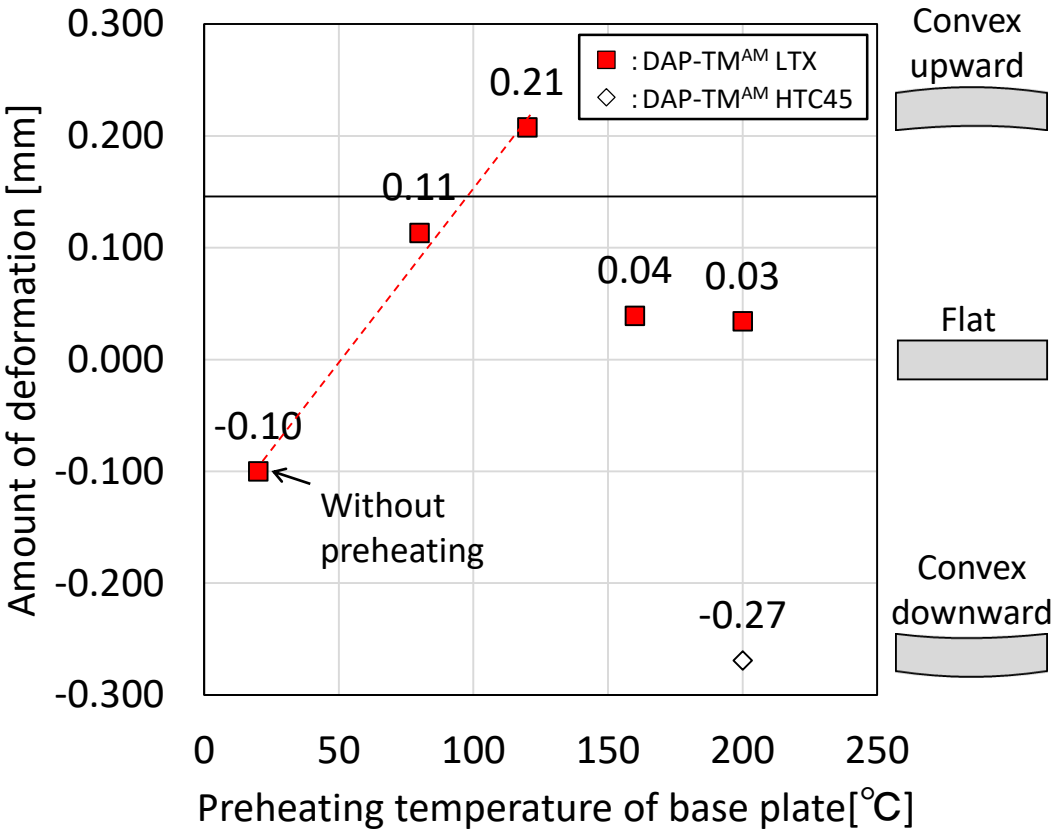


Fig.3 Relationships between preheating temperature of base plate and amount of deformation of 3D-printed sample.

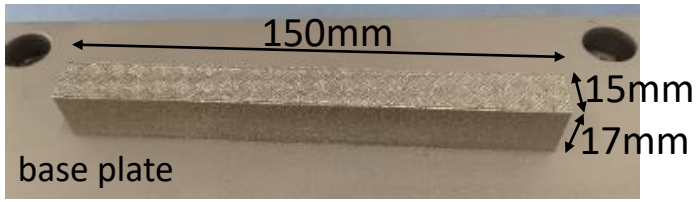


Fig.4 the overview of 3D-printed sample.

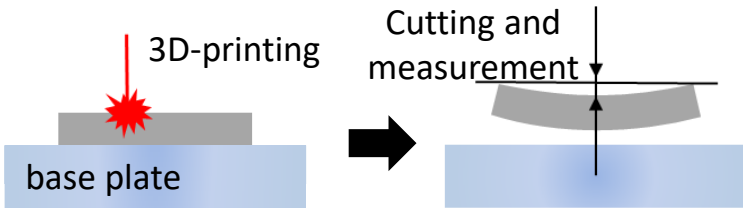


Fig.5 schematic diagram of the deformation measurement method.

Tempered hardness and thermal conductivity

- Tempered hardness is almost equal to that of H13.
- Maximum hardness of 52HRC can be obtained by tempering at 550℃.
- Thermal conductivity is equivalent to H13.

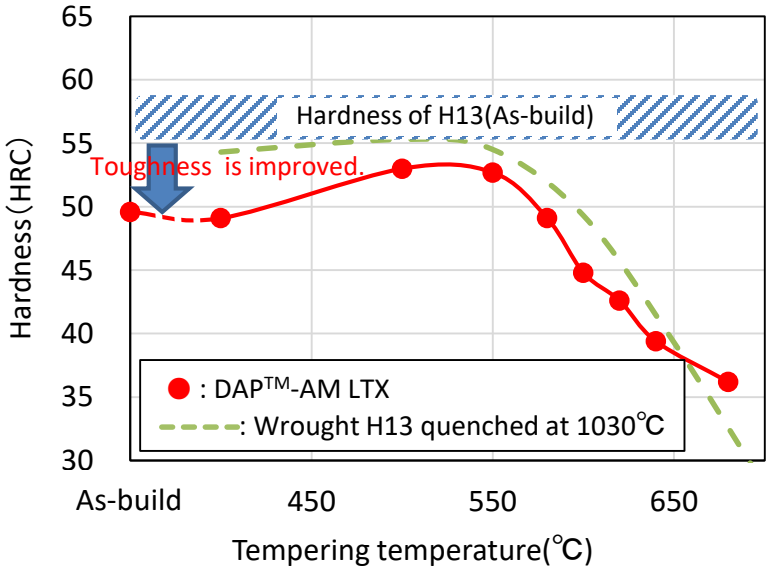


Fig.6 Tempering Hardness of DAP™-AM LTX compared to H13.

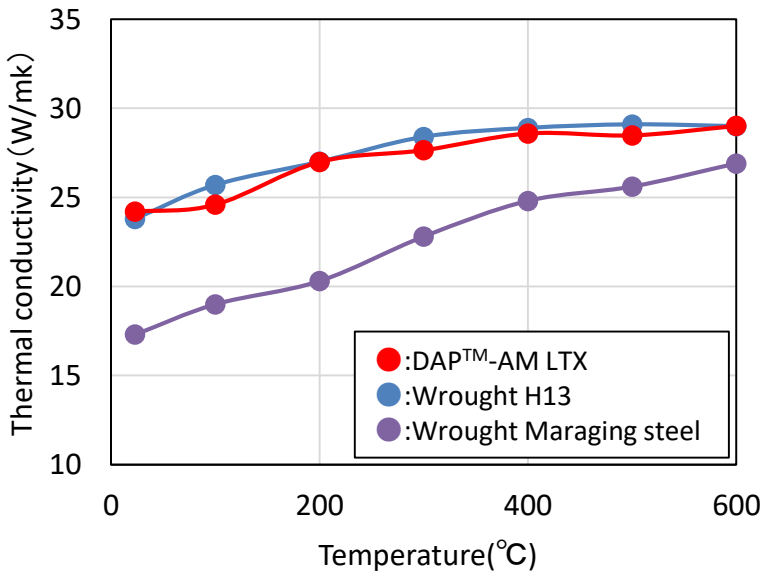


Fig.7 Thermal conductivity of DAP™-AM LTX compared to H13 and maraging steel.

Mechanical properties

The tensile strength and 0.2% proof stress are equivalent to that of wrought H13 type steel with the same hardness as DAP™-AM LTX.

The impact value is higher than that of wrought SKD61 type steel with the same hardness as DAP™-AM LTX.

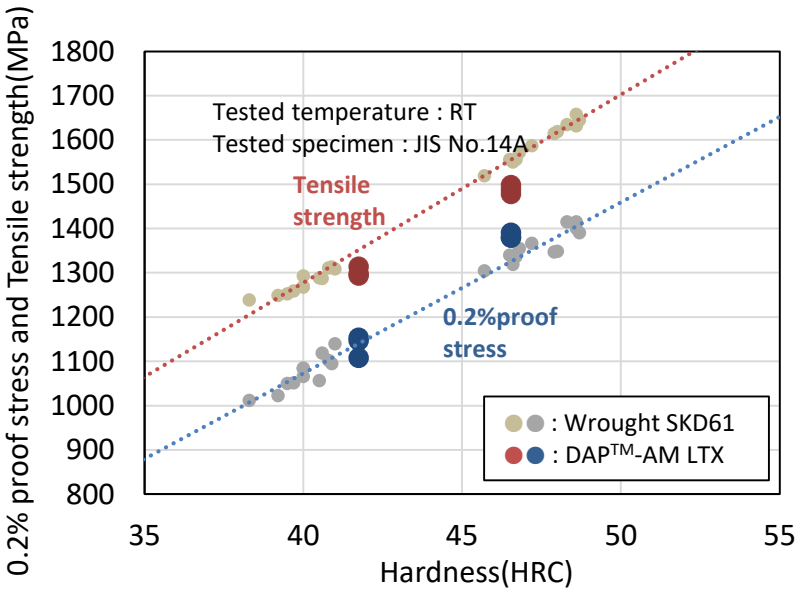


Fig.8 Relationship between hardness, 0.2% proof stress, and tensile strength.

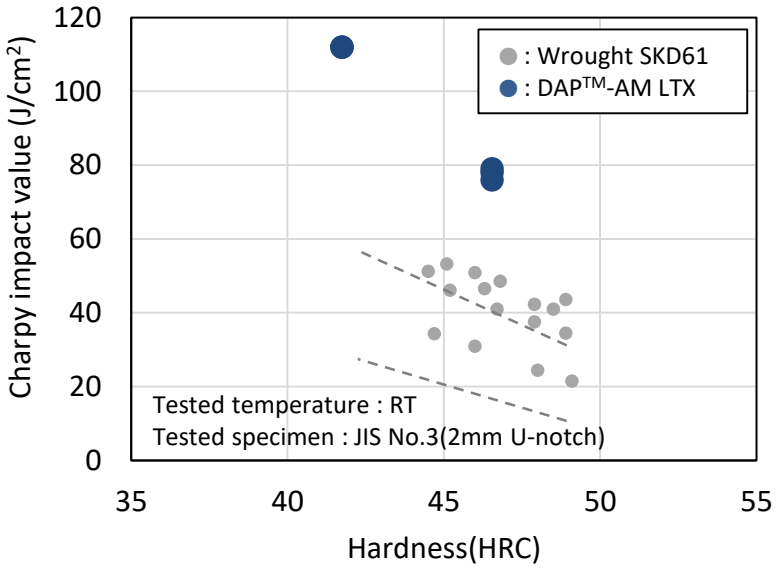


Fig.9 Relationship between hardness and Charpy impact value.

Heat checking resistance

The heat check resistance of DAP™-AM LTX is equivalent to that of SKD61 steel.

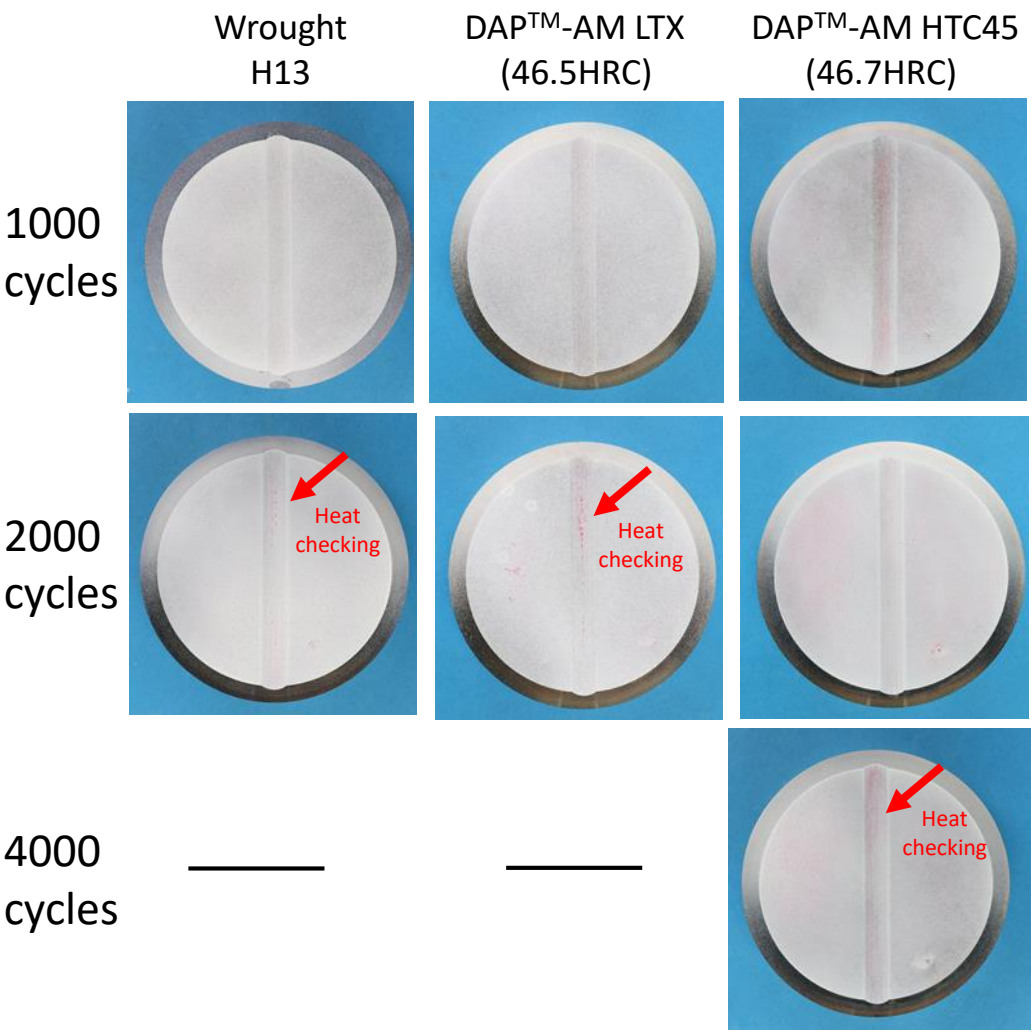


Fig.10 the results of the Heat cracking test.

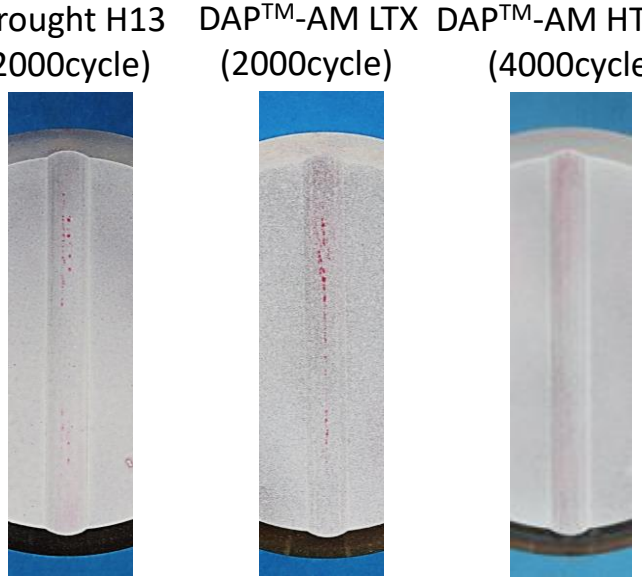


Fig.11 Magnified view of the notch area when heat checking occurs

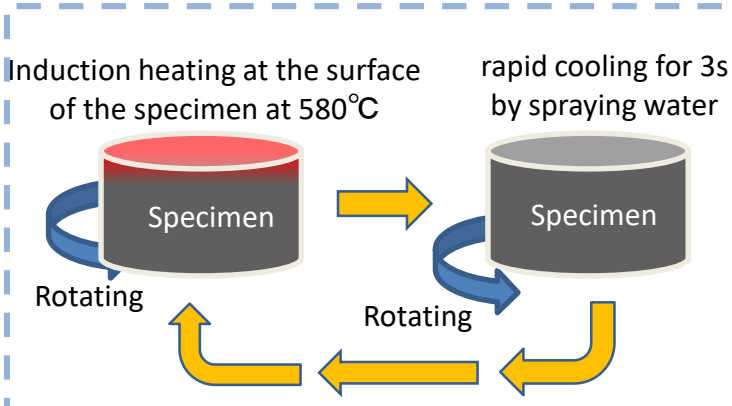


Fig. 12 Schematic diagram of the heat cracking test.

Nitriding Properties

Nitriding properties are almost equivalent to those of SKD61.

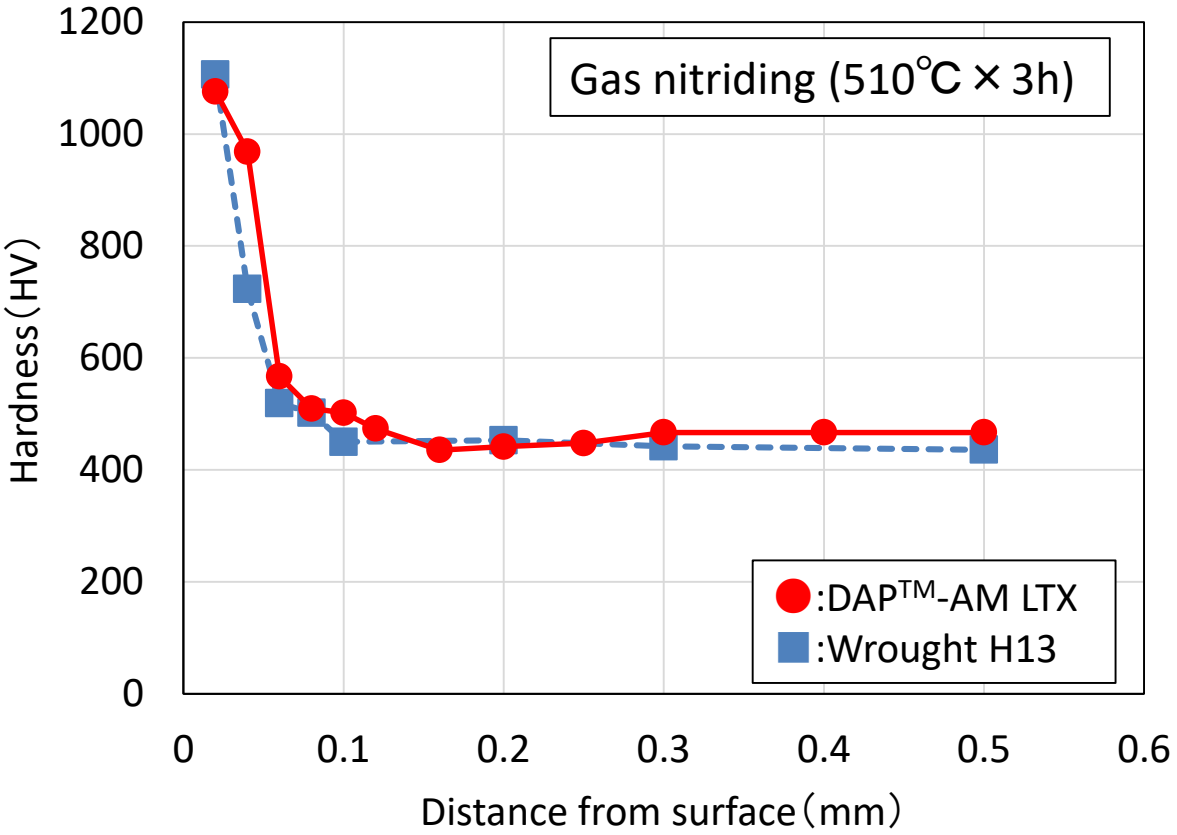


Fig.13 Hardness distribution from surface layer after nitriding

3D printing process parameters for DAP^{TM}-AM LTX

The data shown in Table 2 are 3D printing process parameters established with Concept Laser M2 machine. When using other equipments, please refer to the table for optimizing conditions.

Table 2. Recommended process parameters

Part		Laser power (W)	Laser spot diameter (μm)	Scanning speed (mm/s)	Hatching distance (mm)	Layer thickness (μm)
Product	Inside	300	180	600	0.13	50
	Contour*	150	100	300	—	50
Supporting part		150	100	700	—	50

The recommended laser scanning pattern is a checker-board type.

*Process parameters for forming outline part
2 times irradiating laser on the contour part
(2nd time is shifted 70 μm inward from 1st time)
can reduce defects in the border
between contour part and inside part.

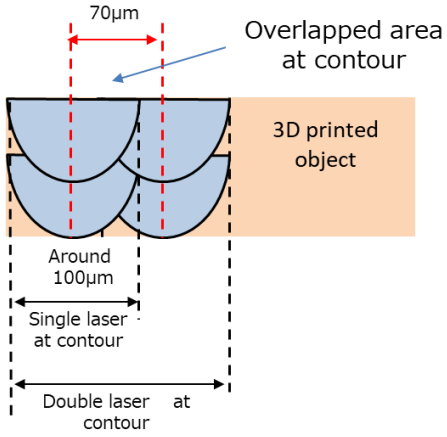


Fig.14 Schematic diagram of 2 times laser irradiation to form the outline part.

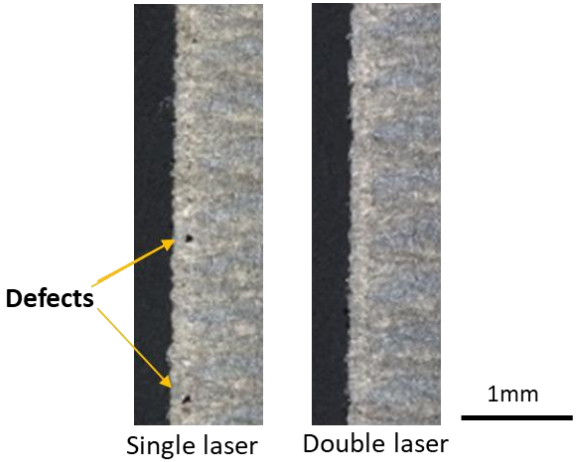
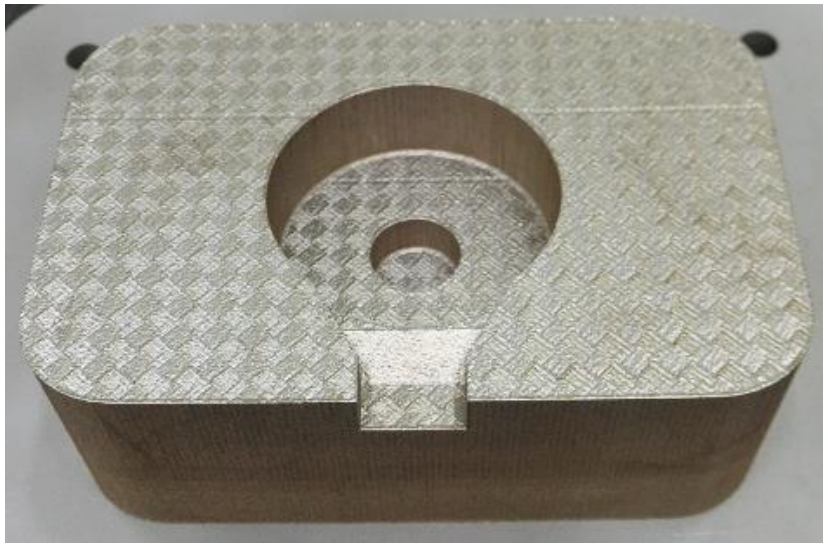


Fig.15 Defects in the border between outer part and inside part.

The example of 3D-printed mold

No cracking was observed in both as-build and tempered samples of maximum hardness.
(Tempering temperature : 550℃)



Manufactured with GE Additive's concept laser M2 machine
Base plate temperature : 160℃

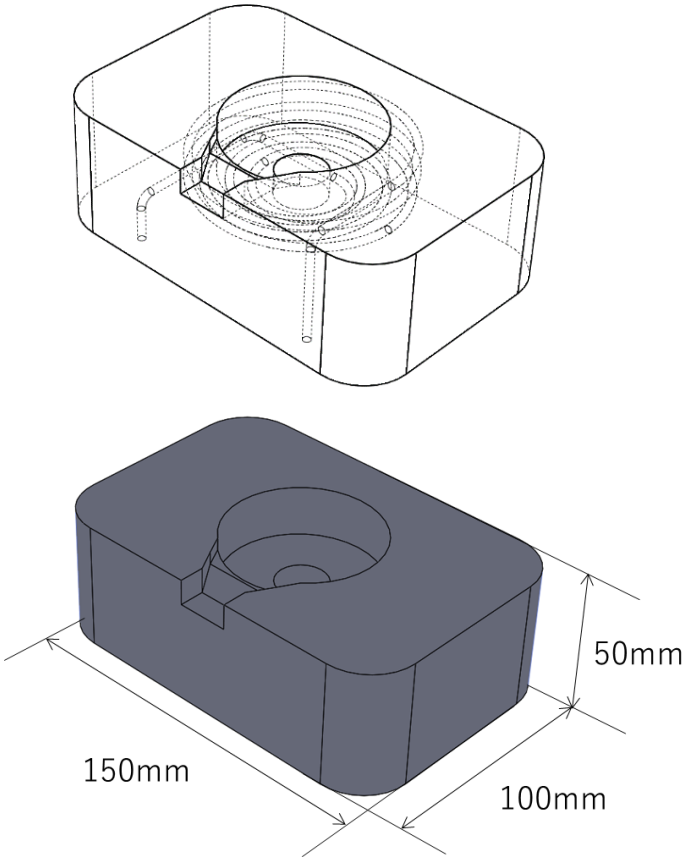


Fig.16 the example of 3D-printed mold.

The example of 3D-printed mold

No cracking was observed in both as-build and tempered samples of maximum hardness.

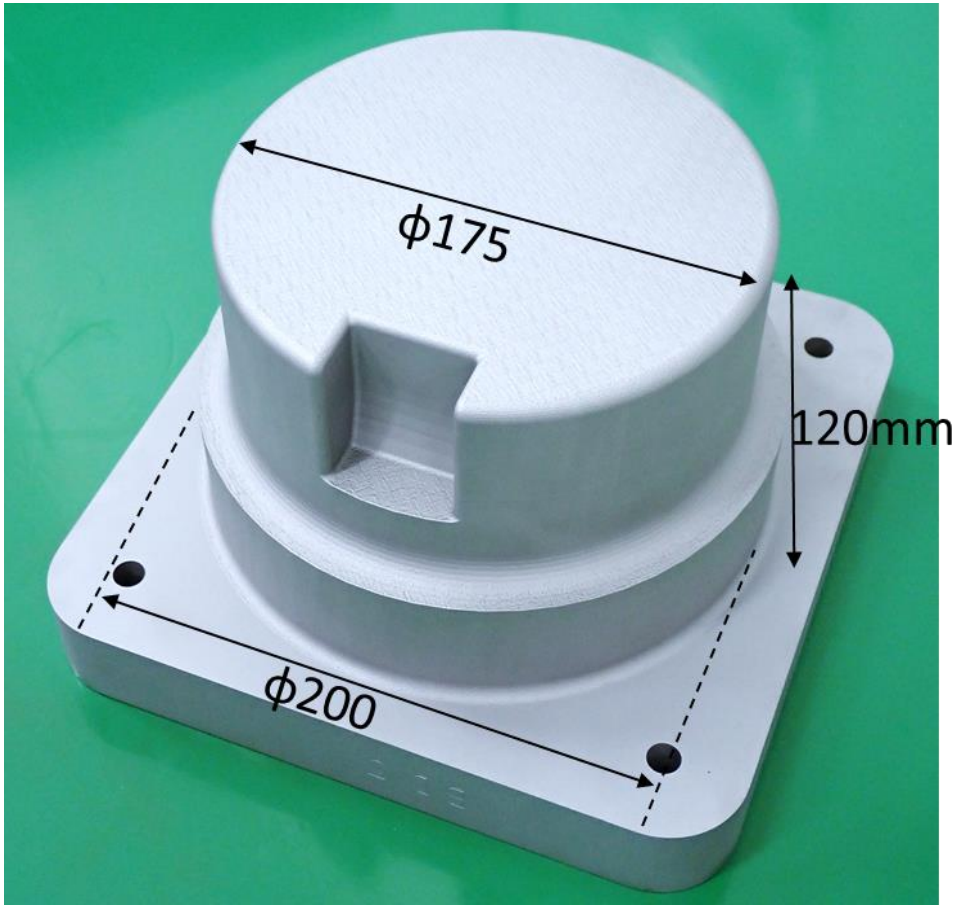


Fig. 17 the example of 3D-printed mold.

Manufactured with GE Additive's concept laser M2 machine (Base plate temperature : 200℃)

Summary

DAP™-AM LTX has the following characteristics,

- By adjusting the temperature of the base plate, internal strain of the 3D-printed product can be reduced and cracking can be suppressed.
- Mechanical properties are equivalent or superior or to those of H13 bulk steel.
- Heat checking resistance is superior to that of H13 bulk steel.