Sinter Forged MMC Components for Wear-parts

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1. Introduction

To achieve high density in PM components great efforts have been made during the past. The sinter forging process is one alternative process route, which can produce full dense PM components.
FJ Sintermetal has during the past years established a sinter forging line with the aim to produce MMC wear parts using the sinter forging technique. The production line, which is flexible, is used for the production of sinter forged MMC materials for wear parts with high wear resistance used in agriculture, forestry and waste industry. To improve the mechanical and wear properties new MMC-alloys have been developed within the project. Those alloys are well suited for the sinter forging process and can be used with high benefits as wear parts. The production line is able to produce the new "low cost" MMC-alloys called WEARCOMP® within close dimensional and structural tolerances, which opens a profitable route to exploit the good properties of the "difficult to machine" MMC-materials. The established sinter forging line is also able to produce low alloy high strength steel components with properties according to Materials Standards for P/F Steel Parts (MPIF Standard 35).

The presentation deals with:

- The sinter forging process established at FJ Sintermetal.
- Mechanical properties achieved on samples produced by the sinter forging process.
- Abrasive rubber wheel test on WEARCOMP® - Wear test results
- Examples of low cost wear parts used in forestry and waste industry.

2. The sinter forging process established at FJ Sintermetal

The sinter forging technique is a method to obtain high density in the final net shape or near net shape components. The aim for this technology is to obtain good mechanical properties in net shape components using a shortcut in the processing route and therefore reduce the final cost for the component. It is well known that this technology has been used in several decades now to produce sinter forged or powder forged connecting rods in the automotive industry. After forging the relative density is near 100% which means that it is possible to obtain enhanced mechanical properties in a homogeny structure.

In 2003 FJ Sintermetal established a new sinter forging line for MMC wear parts used in the waste industry, agriculture and forestry. The pre-forms are pressed in a conventional powder press with a conventional powder tool. The pre-form is then de-waxed and sintered in a special design furnace for the sinter forging technique. The furnace is a pusher furnace and can run up to 1250 °C in a reducing atmosphere as endogas or formiergas. After sintering the pre-form is taken out of the furnace in hot condition and forged in a mechanical forging press with a forging die to final shape.
The final sinter forged component can thereafter be heat treated if needed.

3. Mechanical properties achieved on samples produced by the sinter forging process

MMC stands for Metal Matrix Composite. In principle iron powder is used as the matrix, and is mixed with hard particles like abrasive materials, metal oxides or ceramics to a homogeny mass.

A sinter forged Mo-alloyed water atomized iron powder was used as the matrix in some of the MMC samples. The mechanical properties for this grade are:

Tensile strength: 1725 [MPa] Elongation: 2 [%]
Yield strength: 1520 [MPa] Macro hardness: 514 [HV30]
Impact strength: 14 [J] Micro hardness: 675 [HV0.1]
Density: 7.85 [g/cm^3] Quenched and tempered.

Four different base powders were prepared with the aim to test the mechanical properties and the wear resistance for some MMC materials called WEARCOMP®.

The WEARCOMP® is a mix of high strength steel and high alloyed steel with addition of carbon. Samples were prepared by the sinter forging technique. The samples were after sinter forging quenched and tempered twice. References were thereafter tested for the wear resistance.

All samples where sinter forged to a density higher than 7.65 g/cm^3 and hardness between 350 and 580 HV30.

4. Abrasive rubber wheel test on WEARCOMP® - Wear test results

The sinter forged WEARCOMP® samples were tested against common wear material with similar hardness like Hardox 600 and D2 in massive material – test performed according to ASTM G65.
The volume loss for some MMC samples was low – twice better than test on conventional wear plates.

5. Examples of low cost wear parts used in forestry and waste industry

Tool for debarking used for preparation of chipwood for production of cellulose in the paper industry are produced as net shape products by the sinter forging technology where machining are avoided. The price and production time are reduced compared to conventional manufacturing.

Hammer bits used in a heavy duty waste recycler are produced as net shape product by the sinter forging technology where post processing is avoided. The price of the bit is less than the half of the original price. The bits operate on a big drum inside the waste recycler with high speed and reduce the waste so it can be re-used. The new bits increase the efficiency and reduce the operating costs for the customer. The capacity of the recycling material from the heavy duty waste recycler is 120 ton pr. hour and the machine operates with a big 1000 horsepower engine. The full dens bit is produced from sinter forged WEARCOMP® without any post processing, which means that the price is very attractive comparing to conventional bits.