Perfectly proportioned: Working to improve dry compaction and sintering

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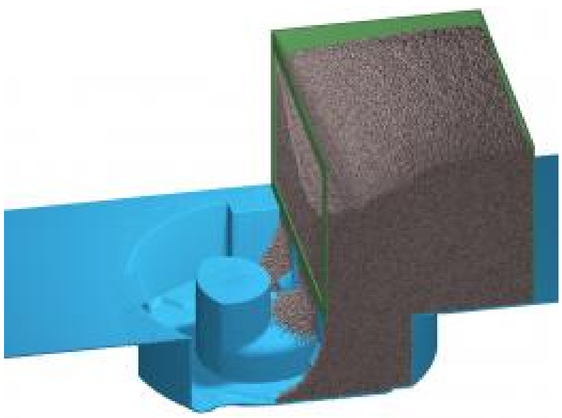

A new simulation technique helps to improve the sintering process: it calculates the best method for achieving an even density of the powder in the mold. (© Fraunhofer IWM)

(PhysOrg.com) -- The manufacture of parts by compaction and sintering involves filling a die with metal powder. Research scientists have simulated this process for the first time to achieve an evenly distributed powder density. This improves the cost-efficiency of sintering.

It all happens very quickly: the feed shoe, configured as an open-bottomed box, moves across a surface in which a recess forms the shape of the desired part. The fine-grained metal powder dropping from the feed shoe settles in the mold. Stamps then compact the loose powder grains at a pressure of several hundred megapascals to produce the "green body" - a preform in the shape of the finished part which now has to be sintered in a furnace at a temperature below the melting point of the material. This procedure ensures that the compacted grain structures become more compressed and harden.

Dry compaction and sintering are common processes in industry. They deliver precisely shaped parts that can withstand high mechanical loads. There is still potential for improvement, however, and Fraunhofer researchers aim to perfect the technique and avoid costly waste.

"Filling the die is a critical step in dry compaction," states Dr. Claas Bierwisch from the Fraunhofer Institute for Mechanics of Materials IWM. "The metal powder is not distributed 100 percent evenly in the mold. These inhomogeneous distributions of density could cause the part to warp or even crack, affecting its loadability, precision and service life," the project manager explains. Up to now an expensive trial-and-error approach has had to be applied to obtain the best results, but this will no longer be necessary with a simulation technique developed by the research scientists for optimizing the filling process.

"By describing the powder numerically we can attach values to virtually every grain," explains Bierwisch. The physical properties, size and shape of the grains as well as the shape of the mold are all taken into account. The research scientists then calculate how and where the powder grains flow into the mold and what the density distribution is like after filling. It is now possible for the first time to realistically simulate the production of three-dimensional parts such as toothed wheels in gear systems or washers in one-hand mixer taps for washbasins.

What's more, the researchers can draw conclusions about the filling process, including how high the speed of the feed shoe needs to be and how it should move. In some cases the shoe only needs to move forwards and backwards. For other parts the die has to oscillate as well. The scientists can simulate the sintering events through to completion of the finished part and can therefore replicate the entire process chain. They are currently optimizing the manufacture of magnetically soft coil cores for wheel hub motors, which could play an important future role in electric vehicles.

Provided by Fraunhofer-Gesellschaft (news : web)