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# Injection Moulding for Aluminium Alloys

## First sintering process for aluminium components

Complicated metal parts today are often manufactured by metal-powder injection moulding (MIM): Metal powder is mixed with plastic, moulded into shape and at high temperatures caked into a solid metal part – this process is referred to as "sintering". For steel or titanium, this method has been applied very successfully for a long time, whereas for aluminium this technique was not suitable to present.

Powder injection moulding offers manifold advantages for mass production of complex small parts. The powder metallurgy process allows for manufacturing complicated shapes that other procedures could not realise at all or only with great effort.

### Objective

The aim of Prof. Herbert Danninger and Dr. Christian Gierl-Mayer at the TU Wien Institute of Chemical Technologies and Analytics was to manufacture components of less weight and larger size than they are usually produced with conventional powder injection moulding. They wanted to be the first to realise aluminium alloy components in a powder injection moulding process. The new aluminium powder injection moulding technique should represent components of complex shapes and enable their cost-efficient production.

### Approach

During the sintering process, metal particles are connected. To enable this connection, the oxide layer covering the metal particles is chemically reduced at high temperatures and the binder is removed. If the conventional process is applied to aluminium, the following problem occurs: The oxide layer surrounding the aluminium particles can only be removed at very high temperatures. At the same time, aluminium has a comparably low melting point limiting the maximum sintering temperature. It is impossible to remove the oxide layer without melting the entire metal part.

Aluminium alloy MIM component
(background: injection moulding part, feedstock, powder)

The team at TU Wien now succeeded in finding a solution to this problem: by using different atmospheres for removing the binder and for sintering.

Usually, an oxygen-deficient atmosphere is used to prevent a metal powder from oxidising completely.

In contrast, for aluminium an atmosphere with high oxygen content is beneficial for removing the binder. The dense oxide layer prevents further reaction of the metal with the atmosphere as long as certain temperatures are not exceeded. The residual binder may be removed completely at comparably low temperatures. Then the atmosphere is switched to nitrogen and the sintering process is carried out.

Partners of TU Wien in the present development of the aluminium powder injection moulding are:
ECKA Granules Germany GmbH,
BASF SE,
Fotec Forschungs- und Technologietransfer GmbH,
Rupert Fertinger GmbH.

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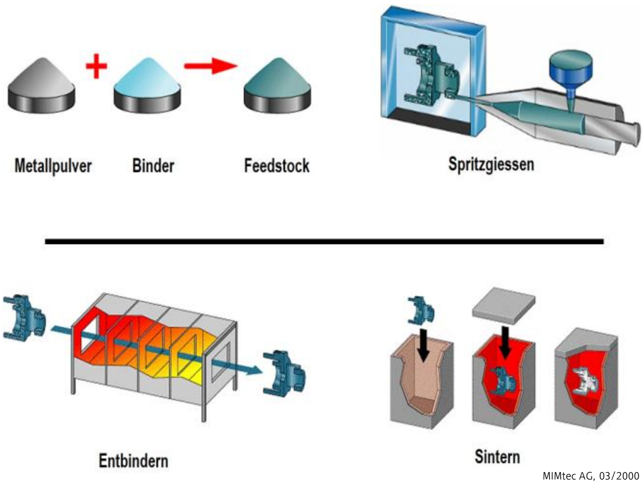
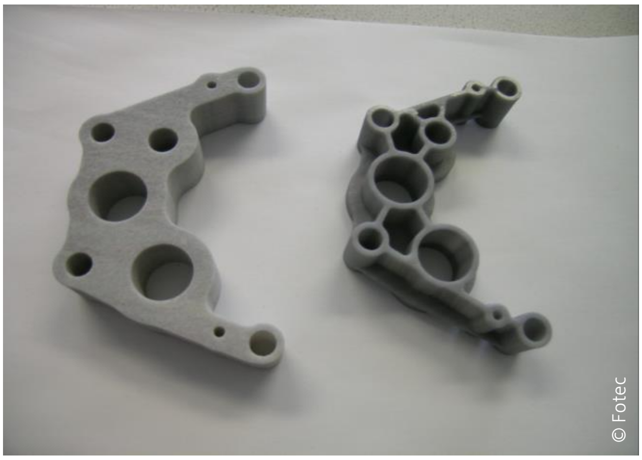
## Results

The new procedure of TU Wien enables the processing of aluminium alloys in powder injection moulding processes. Even complex geometries that do not qualify for conventional machining may be realised now. With an optimised design, considerable material savings of more than 50% may be realised while maintaining the same functionality. In addition, the powder raw material for aluminium alloys is comparably cheap. The costs for producing even larger components than with MIM of other metals are therefore manageable. In principle this technique is able to process both aluminium forging and casting alloys, which implies that both solderable and thermosetting products may be manufactured.

Numerous industrial applications qualify for this new aluminium sintering method. Due to its low density, especially aluminium is of particular interest for




MIM: Metal powder, Binder, Feedstock, Injection moulding, Debinding, Sintering




Design studies: conventional (left), MIM design (right)

many applications – for example when it is important to save weight such as in automobile construction or in aerospace engineering. But also for machine tools or watches the aluminium sintering method could open up new possibilities.

## Benefits

- Material saving and thus weight reduction of up to more than 50%
- Complex geometries for large-scale production from aluminium alloys
- Forming at reduced weight and cost while maintaining the functionality (compared to conventional machining)
- No need to assamble individual parts – with appropriate design
- Manufacturing of larger MIM parts than previously feasible from an economic point of view – due to inexpensive raw material

### Notes

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