Technical University of Denmark

Popular science summary of the PhD thesis

PhD student	Christian Lyck
Title of the PhD thesis	Powder Metal Extrusion of TWIP Steel Components
PhD school/Department	Department of Civil and Mechanical Engineering

Science summary

* Please give a short popular summary in Danish or English (approximately half a page) suited for the publication of the title, main content, results and innovations of the PhD thesis also including prospective utilizations hereof. The summary should be written for the general public interested in science and technology

The extrusion of thin-walled metallic profiles from clay-like metal powder feedstock has not previously been applied at a large scale in the industry. The manufacturing technology, nevertheless, has some great unexploited potential. The technology provides freedom with respect to alloy composition and geometrical design. It allows high-strength, tough alloys, like TWIP and TRIP steels, to be extruded into weld-free, thin-walled honeycomb profiles that reduce component mass and improve energy absorption. This makes MPE a promising manufacturing technology for crash management components in the transportation industry.

The PhD project has focused on the development of powder-based TWIP steel, specifically for MPE. The work has touched upon all concepts related to MPE, from feedstock preparation, extrusion, debinding, sintering, and testing of MPE steels.

The research project has combined in-house knowledge, theory on powder metallurgy, physical metallurgy, thermodynamics, organic chemistry, and experimental work. A particular focus has been put on studying the debinding of MPE steels and on experimental testing of MPE TWIP and TRIP alloys.

The research project explores the debinding characteristics of cellulose-derived products experimentally in various atmospheres and covers how the different debinding atmospheres affect the mechanical properties of sintered components. It was found that cellulose-derived products, commonly applied for powder metallurgy, carburize the components if not debound in oxygen-containing environments and that the carburization can be detrimental for the final alloy due to lack of densification and changes to the stacking fault energy of the alloy.

The research project also covers the challenges related to the adaptation of high Mn TWIP steels to the powder metallurgy processes. Suggestions on TWIP and TRIP alloys suitable for the MPE are made. The suggested steels are manufactured, their mechanical performance is characterized, and the findings are compared with available data from the scientific literature on similar alloys. The research project furthermore explores high-temperature solution nitriding as a tool for tailoring the deformation behavior of these steels.

Please email the summary to the PhD secretary at the department