

# in FOCUS

PHS

**METAKUS**  
Automotive

## Milestones in Automotive Lightweight Design

PRESS HARDENING ...

... IT'S OUR GENETIC CODE!

# Knowledge at First Hand!

## The author



Univ.-Prof. Dr.-Ing. habil. **Kurt Steinhoff** holds the Chair of Forming Technology at the University of Kassel (GER) and is the founder of METAKUS Automotive GmbH, Baunatal (GER). He is considered one of the pioneers of modern press hardening.

**METAKUS Automotive GmbH**  
Fehrenberger Straße 1a  
34225 Baunatal / Germany

Tel.: + 49 (0) 561 9880 5566  
contact@metakus.com

## New Textbook for Study and Postgraduate Training

Professor Steinhoff recently presented his new textbook "**Press Hardening - From Theory to Application**". It contains a comprehensive presentation of the technological characteristics of press hardening that can be found in the current state of the art. This ranges from the basic process idea through its process-technical realization to its large-scale application in modern lightweight and safety structures in vehicle construction. The historical development and underlying driving factors are explained, as are the increasingly complex characteristics of press-hardened products in vehicles, including their impact on the complexity of the manufacturing process itself. In addition to extensive application examples and technological background information, market developments and forecasts are also presented in an explanatory manner.



## The Rest is History ...

The idea of providing different **properties in a range from soft to hard** as an integral part of a forming process by means of locally different heat treatment in a single component was already successfully realized by Professor Steinhoff in the 1990s as a prototype on an automotive component. It was only with the basic knowledge acquired at the University of Kassel (GER) that such a component could be installed for the first time in a vehicle body in series production at Volkswagen AG's Kassel plant as a B-pillar reinforcement under his guidance from 2006 on. **Today, such and other body components with tailored properties can be found in a large number of vehicles - worldwide.** The fact that this groundbreaking idea originated in Kassel is increasingly being forgotten.

**[www.metakus.com](http://www.metakus.com)**



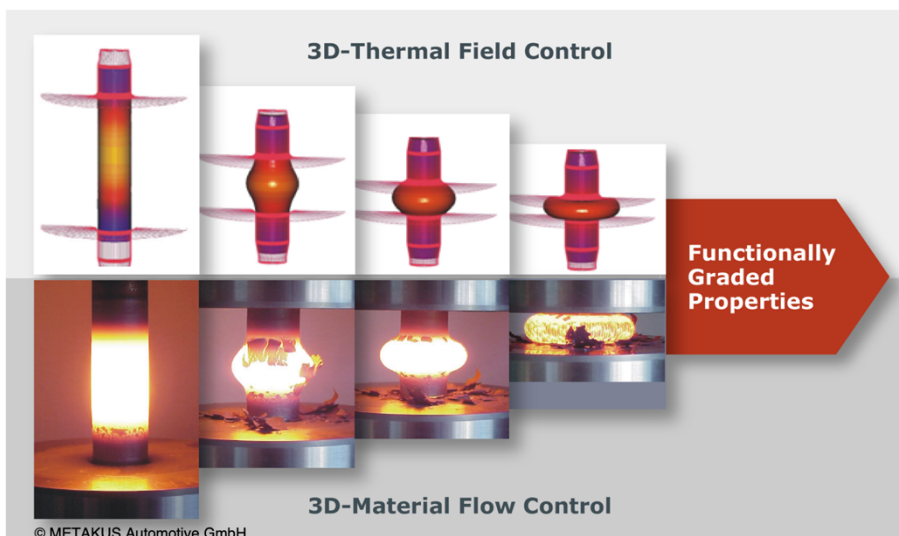
**2006:** First application of a thermo-mechanically tailored body component in large-scale automotive production; the highly ductile foot section of the B-pillar reinforcement enables controlled energy absorption, while the ultra-high-strength center and head sections provide intrusion resistance and rollover stability



## Functional Gradation - From Dream to Reality

The idea of functional gradation, i.e., a distribution of mechanical-technological component properties oriented to the load profile under its application, first appeared in the early 1960s. It was actually a response to the traditional integral design approach, which followed the assumption that a component could have only one singular property-setting oriented to the highest load over its entire spatial extent - although this often occurred only in locally limited component areas.

Unfortunately, it is not possible to manufacture a specific component by simply taking property modules from a kind of construction kit and assembling them according to the pattern of its individual load profile. Although there was no lack of wishful thinking, for a long time there simply was no "brilliant" idea of how such a component could be manufactured with efficient production technologies.

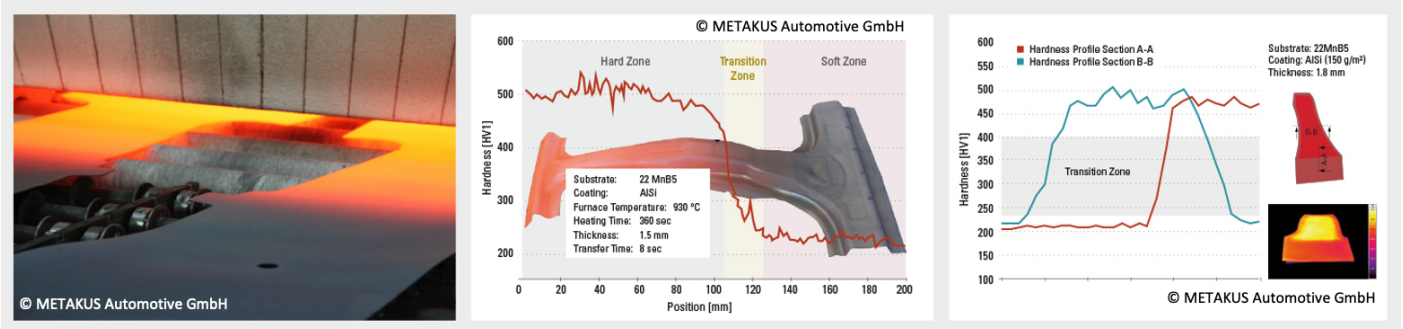


**1996:** First test of functional gradation of component properties by simultaneous 3D temperature field and material flow control in a bulk forming process



# Tailor-Made for the Challenges of the Future

**So, what was the decisive transmission step into industrial mass production?** With their initial developments in the mid-1990s, Professor Steinhoff and his team demonstrated that such a design approach could be applied to monolithic, i.e., one-piece, workpieces made of traditional construction materials if it were possible to synchronize geometric complexity with a similarly complex distribution of material properties within a single component in terms of process technology. The approach pursued here, **forming processes with locally and temporally variable temperature control**, represented a **real pioneering achievement** for the industrial mass production of functionally graded components.



**2006:** Differential intermediate cooling during press hardening is used for the first time in large-scale production for targeted property gradation of body components

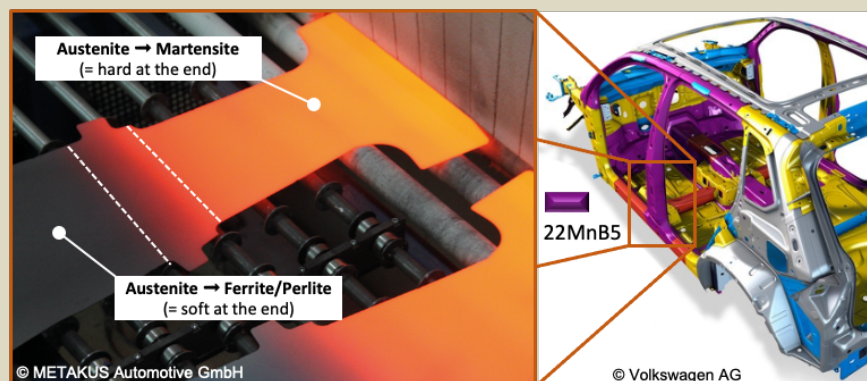
**2004:** Characteristic hard-soft property profile in a B-pillar reinforcement after press hardening in a die with locally and temporally variable thermal process control (differential cooling); heated and cooled die inserts

**2011:** Hardness profile and thermographically recorded temperature profile of a tailor-heated B-pillar blank; complex soft-hard pattern due to differential intermediate cooling by application of a "mask"-device

## Making an Idea Fly - Taking Off toward Automotive Lightweighting & Safety

A key factor was undoubtedly the collaborate research center TRR 30, which was established for the first time at the University of Kassel by the German Research Foundation. It were the scientific findings on integral heat treatment and hot forming developed in this program, which then paved the way for press hardening being successfully implemented into the core area of the vehicle structure via a systemic arrangement of a completely new generation of steel components with highly complex geometry, highest strength and extremely low weight in form of a kind of "safety cage". However, the real potential of the available technological expertise could not be exploited by this. There was far more innovation potential to bear!

This potential was to unfold only when the incompatibility of highest strengths for intrusion resistance and high ductility for energy absorption threatened to become an increasingly critical moment for the coupling area of the B-pillar lower part to the floor assembly. The solution to such conflicting safety requirements was thus obvious: **Adjustment of a thermo-mechanically tailored hard-soft property distribution as an integral part of press hardening.**



### "Made in Kassel" since 2006:

A large number of body components carry the "genetic code" of the first functionally graded B-pillar reinforcement in the Volkswagen Tiguan model



## A Global Success Story

In the early 2000s, i.e. more than two decades after the initial idea, this novel design approach was thus able to develop into a global megatrend in the field of manufacturing ultra-lightweight, and, at the same time highly safe body components for vehicle construction. However, when it comes to designing and optimizing such highly complex processes, the "world" always returns to where it all began, and, by that making Kassel (GER) to "the" meeting point of the international press hardening scene.

*A real **pioneering achievement** in 2004:  
Prof. Dr. Rüdiger Weißner, Managing  
Director of Volkswagen AG's Kassel plant,  
and Prof. Dr. Kurt Steinhoff have brought  
press hardening "to the point"*



## At the Intersection of Science and Industry

This technological breakthrough and the unique expertise of Professor Steinhoff and his team have enabled a **world-class technological hotspot for press hardening** to develop since 2006 with the initial establishment of the METAKUS Center for applied Metal Forming Technology in public-private partnership between industry and the University of Kassel. Countless impulses have originated there and essential developments have been and are still being brought to market maturity from here: **"road tested" for industrial series production**. The symbiosis of scientific research and industrial development coupled with top-class education and postgraduate training makes Kassel "the" **cadre training ground for press hardening**.

In the meantime, METAKUS has become **completely independent** from any public funding and/or third-party sponsorship. As a 100 % private company, managed in the spirit of a small- & medium-sized enterprise, and, profitable for many years, today's METAKUS Automotive GmbH operates worldwide with a team of highly specialized engineers and technicians. It is not only regarded as "the" market leader in its specific field of technology, but is probably what is called a **"hidden champion"**.



**2007: Official ground-breaking ceremony for the construction of the METAKUS building in Baunatal on July 13, 2007 in the presence of the Hessian Minister of Economics, Transportation and Regional Development Dr. Alois Rhiel (third from left)**

