# MODULE AL – HOT STAMPING OF ALUMINUM ...

Compared to press hardening of steel (PHS), hot stamping of Aluminum (PHA) constitutes a completely different story.

This is finally due to the specific hardening mechanism, which leads in both cases to a significant increase in material hardness. While for steel the increase of material strength is affected by a controlled phase transformation, for Aluminum it is precipitation hardening.

As the governing metal physical phenomena and kinetics of both mechanisms are considerably different, integrated heat treatment and forming have to be approached by accordingly different process strategies.

Our **Intensive Training in Press Hardening Module AL** specifically has been developed to transfer all relevant knowledge and skills needed to perform hot stamping of Aluminum wrought alloys with special focus on automotive body-in-white application.

The technological core of PHA, i.e. the integration of hot forming and heat treatment for alloys EN AW-6082 (AA6082) and EN AW-7075 (AA7075), is explained as well from a materials technology as from a process technology perspective.

Module AL therefore constitutes a 3-day journey from theory to practice covering aspects e.g.

*Hot stamping of Aluminum isn't just a change of material, it's a change of the whole process approach.*

- > Metallurgy and alloy concepts of Aluminum, particularly of Aluminum wrought alloys
- > Strengthening mechanisms, precipitation hardening, micro structure & mechanical properties
- > Metallography, microscopy & mechanical testing
- > Heat treatments of Aluminum vs. Steel
- > Conventional forming strategies vs. PHA + process strategies
- > Influences, selection & adjustment of process parameters
- > Efficient PHA processing and property gradation.

MODULE AL

Unit AL1: Fundamentals of Aluminum

Unit AL2: Forming of Aluminum

Unit AL3: Hot Stamping of Aluminum Alloys

**Figure 1: Line-up of learning units of Intensive Training in Press Hardening Module AL**

# ... IS A COMPLETELY DIFFERENT STORY

**Target Audience**

The Intensive Training in Press Hardening Module AL is aimed to found a basis and enlarge the knowledge in the new emerging field of hot stamping of high strength Aluminum. It is therefore a useful addition of skills to engineers, technicians, and foremen in the fields of production and quality assurance, as well as maintenance, production planning and control, marketing & sales, and tool design and manufacturing.

**Program**

The training contents are divided into 3 topical units.

### *Unit* AL1: *Fundamentals of Aluminum*

Contents. This first unit covers the fundamentals of lightweight metal Aluminum concerning alloy concepts, classifications, resulting processing strategies and common applications as well as the underlying metal physical phenomena of strengthening and softening mechanisms affecting mechanical properties. On this foundation, basic phase diagrams and particular heat treatment strategies of high-strength wrought Aluminum alloys will be explored and compared to those of steel for elaborating the main differences. Supporting lab internships will make tangible the fundamental correlations in processing and heat treating of Aluminum.

Aims & Targets. Having acquired a deep knowledge about the specifics of heat treatable wrought Aluminum participants will obtain an understanding for the necessary adaptations and changes in hot stamping strategies when changing from steel to lightweight metal Aluminum. They will further be able to identify the main influencing parameters and recognize the particular role of temperature, time and plastic deformation on the evolution of mechanical properties.

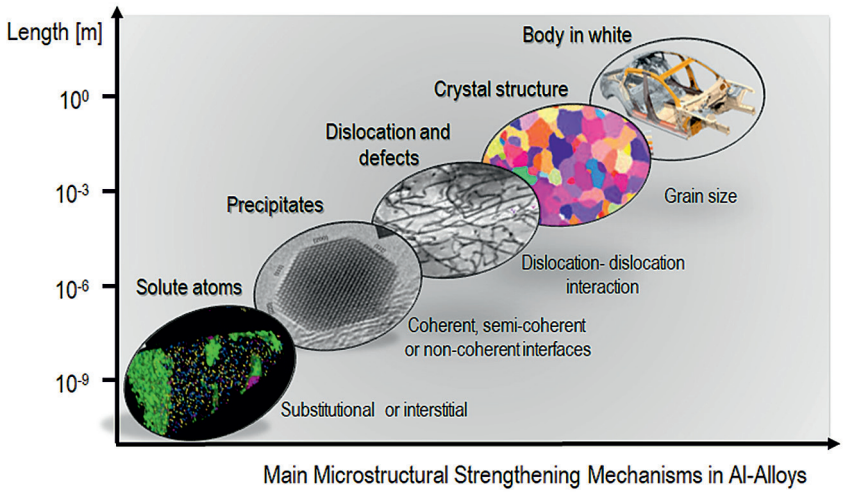


Figure 2: Size ratios of strengthening mechanisms acting in Aluminum alloys.

### *Unit* AL2: *Forming of Aluminum*

Contents. Understanding the deformation behavior of Aluminum at room temperature and with increasing temperature levels is crucial for a successful implementation of hot stamping of wrought Aluminum alloys. Fundamental mechanisms will be explored and a special focus will be set on the dependence between microstructural state and deformability as this differs to mechanisms known for steel. Characterization of formability and forming limits will be introduced as well as special cold and hot forming processes aside of hot stamping will be presented for completing the knowledge base.

Aims & Targets. With the background developed about the particular influence of microstructural features on deformation behavior in combination with time and temperature participants will become aware of process limits. They will also gain insights in how to overcome such limits setting up new strategies in hot forming of high strength Aluminum.

### *Unit* AL3: *Hot Stamping of Aluminum Alloys*

Contents. The last unit constitutes the core part of the training. The challenge in adapting press hardening for high strength Aluminum is to be aware of all the different influences throughout the complete process chain and to combine them in an efficient way without trapping into pitfalls of detrimental side effects. Therefore, in the presentations each single process step from heating, transfer and combined forming and cooling to the final ageing will be explored in detail. Variants in each step will be evaluated for the two typical representatives of high strength Aluminum, EN AW-6082 (AA6082) and EN AW-7075 (AA7075), with respect to the evolution of final properties and process time. The underlying metal physical mechanisms and material-oriented effects such as precipitate nucleation and growth during hardening, dislocation interactions in combination with microstructural features as well as the interplay with plastic deformation will be explained supportively.

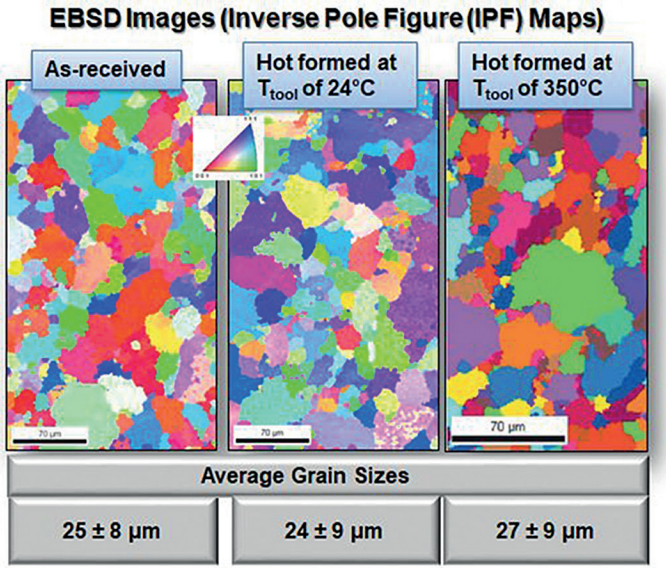


**Figure 3: Evolution of grain size in high strength Aluminum depending on hot stamping conditions.**

A special focus will be on efficient processing leading to significant timely reductions and easier implementation under common industrial conditions. Besides the possibility of creating functionally graded properties by differential cooling strategies within the hot stamping process will be introduced. Practical work in the laboratory will reinforce the gained knowledge by experiencing hot stamping experiments and the impact of process parameters of final properties.

Aims & Targets. With this knowledge base, participants will acquire the ability to reliably implement and handle the most common high strength Aluminum alloys for press hardening applications. It enables them to make appropriate process parameter choices as well as to identify possible adaptations for increasing process efficiency. They will further be prepared for the development of functionally graded lightweight components in terms of adjusting defined property gradation patterns.

*Using Aluminum isn't just simply about changing the material system, it is about changing the perspective in hot stamping.*

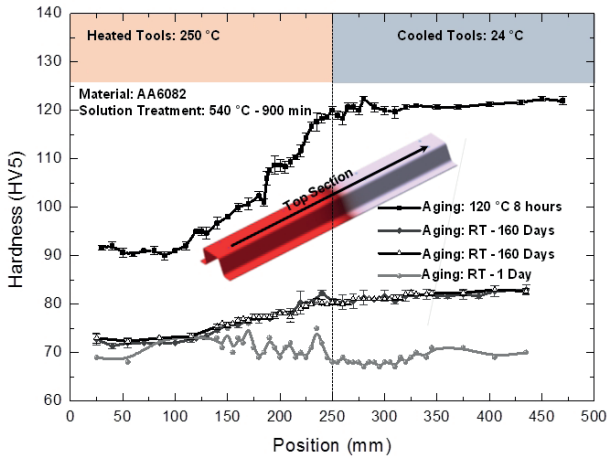


**Figure 4: Tailoring of mechanical properties by hot stamping of high strength Aluminum.**

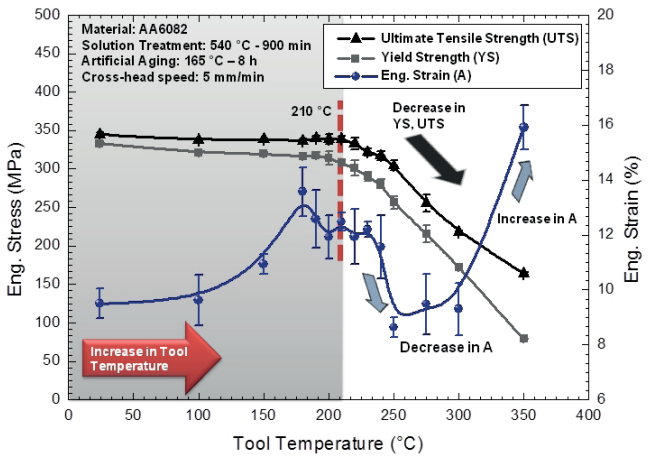


**Figure 5: Evolution of mechanical properties with regard to tool temperature.**

### Schedule Module AL

The training consists of three full days of seminars and lab internships. It takes place at the METAKUS PHS Training Center in Germany.

| Schedule | 1st Day | 2nd Day | 3rd Day |
|---|---|---|---|
| AM | Welcome & Introduction | Unit AL1 Lab | Unit AL3/A Seminar |
| | Unit AL1/A Seminar | Unit AL1/B Seminar | Unit AL3 Lab |
| Noon | Lunch break | Lunch break | Lunch break |
| PM | Unit AL1/A Seminar | Unit AL2 Seminar | Unit AL3/B Seminar |

**Figure 6: Three-day schedule of Intensive Training Module AL.**

contact@metakus.com
www.metakus.com