PRESS RELEASE

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With low pressure to the lightweight aircraft

IWS engineers design modern aluminum components for future aircraft

(Dresden/Berlin, April 23, 2018). Engineers at the Fraunhofer-Institut für Werkstoff- und Strahltechnik IWS in Dresden have developed an innovative process in cooperation with industrial partners to weld and form modern lightweight parts for aircraft. They present this technology at the International Aerospace Exhibition ILA in Berlin from 25 to 29 April 2018.

To produce complexly shaped and large-format components from particularly light aluminum alloys IWS experts combine two processes: friction stir welding (FSW), in which a rotating tool – due to its friction on the material – ensures the necessary heat during welding, and the so-called creep-forming process. "This development paves the way for lighter aircraft that consume less kerosene, can transport more passengers as well as payload and can also be manufactured cost-effectively," estimates Dr. Jens Standfuß, who coordinates the project and heads the business unit Joining at IWS.

This is particularly important for the aviation industry. Anyone who possesses light, low-maintenance and low-cost aircraft with lower fuel consumption and more payloads has a competitive advantage over the market. In addition, economical consumption of materials and kerosene also protects the environment. It is important to know that industry and researchers try in different ways to reduce the weight of aircraft parts. Some rely on carbon and various fiber composites. Others try to lighten the aircraft's outer skin with improved metal alloys. However, such materials should also be suitable for industrial production in large quantities. In addition, they must exhibit a high damage tolerance during operation – a "small" crack must not lead to complete structural failure.

Pressure chamber must reliably protect passengers

Above all, however, these materials must withstand the considerable temperature and pressure differences as well as corrosive stresses between the icy atmosphere outside and inside the passenger cabin during years of practical use at great heights. This cabin resembles ultimately a large heated pressure vessel to protect the passengers: An artificial overpressure must be created in the thin, cold air at an altitude of ten

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kilometers so that people can survive this journey at all. Only selected materials qualify for these tasks.

These materials also include a special metallic compound of aluminum, magnesium and scandium. This alloy, called AA5024 AlMgSc by experts, will be used by aircraft manufacturers for fuselage structures of passenger aircraft in the near future. AA5024 is as strong as aluminum alloys previously used in aviation, but about five percent lighter and more resistant to corrosion. "That does not sound like much," admits Jens Standfuß. "But every kilogram counts on board. The only problem is that conventional processes do not allow this material to be perfectly formed into the spherical structure - bent into two dimensions – which is required to assemble large structures for future aircraft from flat sheet metal."

The material becomes accustomed to the new shape

"Today, industry usually uses stretch forming to shape components spherically," Jens Standfuß explains the initial situation. "This requires very large machines to draw the component in different directions." However, this industrial stretching line fails with the promising aluminum alloy AA5024. As part of its "Aviation Research Programme" (LuFo), the Federal Ministry of Economics and Technology therefore supported the engineers from Airbus and Fraunhofer in solving to this problem. In this process, the IWS team developed a creep forming process. The welded sheet is placed on a pattern mold and locked airtight at the edges. Subsequently the engineers warm the aluminum alloy with heating mats and simultaneously generate a vacuum in the pattern mold. This negative pressure draws the sheet into the depth, the heat guarantees its ductibility. After a certain time the material "creeps", as the expert says: "The tensions are reduced and the sheet metal 'relaxes', that is, it 'gets used to its new form", explains Standfuß. "The initially elastic deformation turns into a plastic one." In this way, spherical structures can be produced cost-effectively in future".

Better and smaller than the stretching bench

"This special version of the creep-forming process is unique worldwide – and for some fields of application almost without alternatives," Jens Standfuß emphasizes. "In the first place, this enables aluminum-magnesium-scandium sheets to be formed precisely into an aircraft segment. Some additional advantages: The creep-forming systems require considerably less space in the work halls than the "stretching benches". The new process also consumes significantly less energy, generates less waste and is more precise.

IWS scientist Frieder Zimmermann, among others, has investigated the method's scientific basis and practical feasibility in test series. He proved that even molded parts already welded from this alloy can be reliably formed in this way. This is particularly important in industrial practice, because many components first have to be welded together and then formed – and of course the weld seams must not fail.
After the first experiments with test sheets, the Fraunhofer engineers will examine the process in the next step with "real components", that is, segments as they are actually installed in the aircraft. However, it will still take some time before the first aircraft takes off from the new lightweight material.

Visit us at the Hannover Messe in hall 5, booth A35 (April 23 –27, 2018) and ILA Berlin (International Aerospace Exhibition) in hall 4, booth 202 (April 25 -29, 2018).

Demonstrator: Circular blank with central-flat welded FSW seam.
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At Westsächsische Hochschule Zwickau, IWS runs the Fraunhofer Application Center for Optical Metrology and Surface Technologies AZOM. The Fraunhofer project group at the Dortmunder OberflächenCentrum DOC® is also integrated into the Dresden Institute. The main cooperation partners in the USA include the Center for Coatings and Diamond Technologies (CCD) at Michigan State University in East Lansing and the Center for Laser Applications (CLA) in Plymouth, Michigan. Fraunhofer IWS employs around 450 people at its headquarters in Dresden.