TALAT Lecture 3501

Alloys and Properties

8 pages, 6 figures

Basic Level

prepared by Klaus Siegert and Manfred Kammerer, Institut für Umformtechnik, Universität Stuttgart

Objectives:

- To provide a background on aluminium alloys suitable for impact extrusion
- To draw attention to raw material parameters which may affect the properties of impact extruded parts

Prerequisites:

- Basic knowledge about the formability of metals
- Background in mechanical engineering

Date of Issue: 1994

3501 Alloys and Properties

Table of Contents:

3501.01 General Information on Alloys and Raw Materials

Aluminium Alloys for Impact Extrusion

Figure 3501.01.01 lists the different types of aluminium alloys used for impact extrusion together with an evaluation considering different aspects. All aluminium alloys of the non-heat-treatable and heat-treatable types can be impact extruded, especially when in their soft annealed state. (See also DIN 1712, part 3 and DIN 1725, part 1).

Aluminium Alloys for Impact Extrusion

Aluminium alloys for impact extrusion

[1)]Merit values, falling from 1 to 4; "-" = not suitable

[2)]Valuation is valid for the original soft annealed state

[3)]S = weldability; L = suitability for brazing. Strength loss due to welding and soldering must be considered!

Source: Aluminium -Zentrale e.V.

Designation according to DIN 1712, p.3 and DIN 1725, p.1	Relative merit values[1)] under various aspects				Remarks
	Impact extrud-ability [2)]	Decorative anodising	Joining process[3)] S	Joining process[3)] L	
Pure and high purity aluminium (DIN 1712, part3)					
Al99.5	1	2	2	1	Main material for impacts
Al99.7	1	2	2	1	
Al99.8	1	1	2	1	
Al99.9	1	1	2	1	Chemical brightening possible
Non-heat-treatable alloys (DIN 1725, part 1)					
AlMn	2	-	2	1	
AlRMg0.5	2	1	2	2	Chemical brightening possible
AlMg1	2	2	2	2	
AlMg3	4	2	1	-	
AlMg2Mn0.3	3	3	1	-	
Heat-treatable alloys (DIN 1725, part 1)					
AlMgSi0.5	2	1	2	3	
AlMgSi1	3	2	2	3	
AlZn4.5Mg1	3	-	2	-	Used only in artificially aged state
AlCuMg1	4	-	-	-	Only for parts with heavy wall thickness which are used only in an aged state
AlZnMgCu0.5	4	-	-	-	

TALAT Training in Aluminium Application Technologies | Aluminium Alloys for Impact Extrusion | 3501.01.01

In order to obtain high quality impacts, it is important to use materials which exhibit a homogeneous fibre structure or a uniform fine-grained structure. A non-homogeneous structure affects not only the chemical and physical properties of the impacts but also their form. An unsymmetrical grain structure can have a large effect on flow stress which in turn might lead to excentricity of the part, warpage or uneven distribution of wall thicknesses.

Reference Values for the Strength of Aluminium Alloy Impacts

Figure 3501.01.02 tables reference values for the strength of aluminium alloy impacts. The aluminium alloys Al99,9, Al99,8. Al99,7 and Al99,5 are mainly used for manufacturing tubes and cans. The alloys AlMgSi0,5 and AlMgSi1 can be considered to be standard materials for impact extrusion. Care must be taken during the machining of the alloys AlZn4,5Mg1 and AlZnMgCu0,5, since the emulsions used can lead to corrosion.

Reference Values for the Strength of Impacts

Attainable mechanical properties, not minimum values

[1] By impact extruding directly after solution treatment and quenching ("freshly quenched" state) and then aging, 90% of the strength of the state "artificially aged" can be attained.

Designation	State	Strength in N/mm²		Elongation
		R_m (σ_B)	$R_{p0.2}$ ($\sigma_{0.2}$)	A_5 (%)
Al99.5/ Al99	annealed impact extruded	70 130	25 110	40 6
Al99.7/ Al99.8	annealed impact extruded	60 120	18 100	40 4
Al99.9	annealed impact extruded	40 100	15 80	40 4
AlMn	annealed impact extruded	90 170	35 145	24 4
AlRMg0.5	annealed impact extruded	80 140	25 110	23 4
AlMg1	annealed impact extruded	105 165	35 145	24 4
AlMg3	annealed impact extruded	190 265	80 215	20 4
AlMg2Mn0.3	annealed impact extruded	155 230	60 200	20 4
AlMgSi0.5 1)	annealed, imp. extr. artificially aged	165 245	145 195	4 10
AlMgSi1 1)	annealed, imp. extr. artificially aged	190 310	170 260	4 10
AlZn4.5Mg1	artificially aged	350	290	10
AlCuMg1	naturally aged	400	350	10
AlZnMgCu0.5	artificially aged	500	450	7

Source: Aluminium-Zentrale e.V.

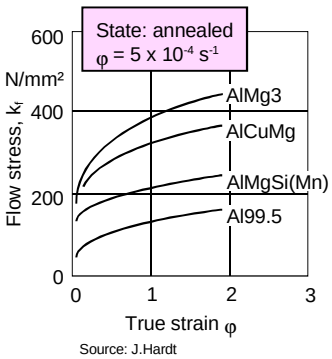
TALAT Training in Aluminium Application Technologies | Reference Values for the Strength of Impacts | 3501.01.02

Flow Curves and Fow Stresses

Figure 3501.01.03 shows flow curves and flow stresses of some aluminium alloys (at left) and the effect of state of heat treatment of AlMgSi1-slugs on the flow behaviour (at right). Flow curves are needed for the calculation of forces for the impact extrusion process. For further flow curves, refer to the VDI guideline 3500.

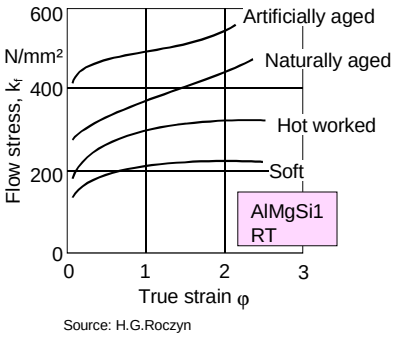
Flow Curves and Flow Stresses

Flow curves for various annealed aluminium alloys at room temperature



Source: J.Hardt

Flow stress as a function of heat treatment state of the slug

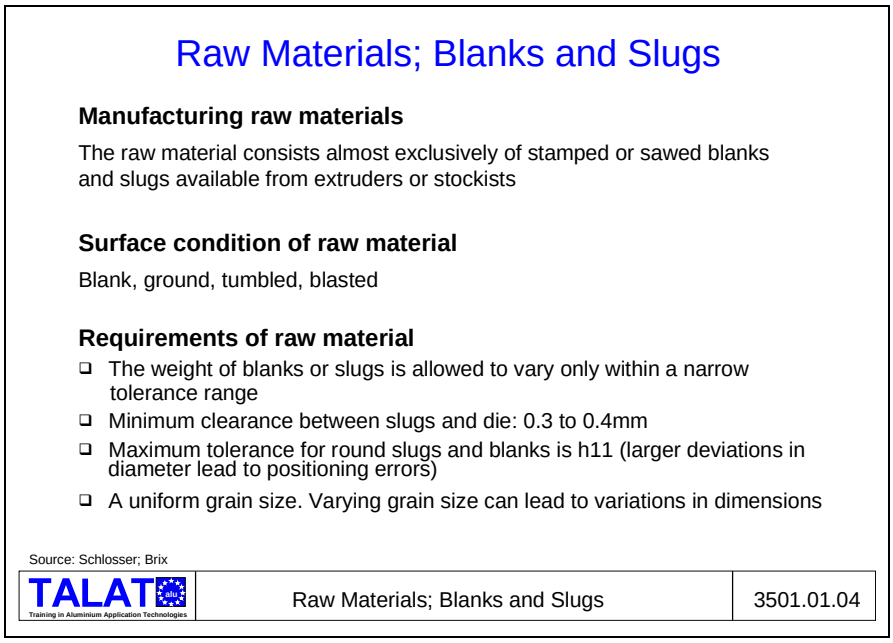


Source: H.G.Roczyn

TALAT Training in Aluminium Application Technologies | Flow Curves and Flow Stresses | 3501.01.03

Raw Materials, Blanks and Slugs

Figure 3501.01.04 gives information regarding the manufacturing of slugs and blanks, their required surface condition and their properties. Cold rolled sheets and rods or tubes from which blanks and slugs are obtained by blanking or sawing, respectively, are standardised in DIN 1745, part 1 and DIN 59604. Round rods of pure aluminium or aluminium alloys are extruded with so-called multiple extrusion dies, i.e. three or four die openings are arranged around the centre of the die. In a final step these rods are cold drawn to size and final dimensions. Since the material is pressed through the multiple die not only from the centre portion of the billet but also from its outer areas, such round rods may exhibit different grain sizes in any one cross-section. As a result, impact extruded parts can warp in unexpected amounts and wall thicknesses may vary. Therefore, care should be exercised, that only single-strand extruded rods are taken as base material for slugs and blanks.



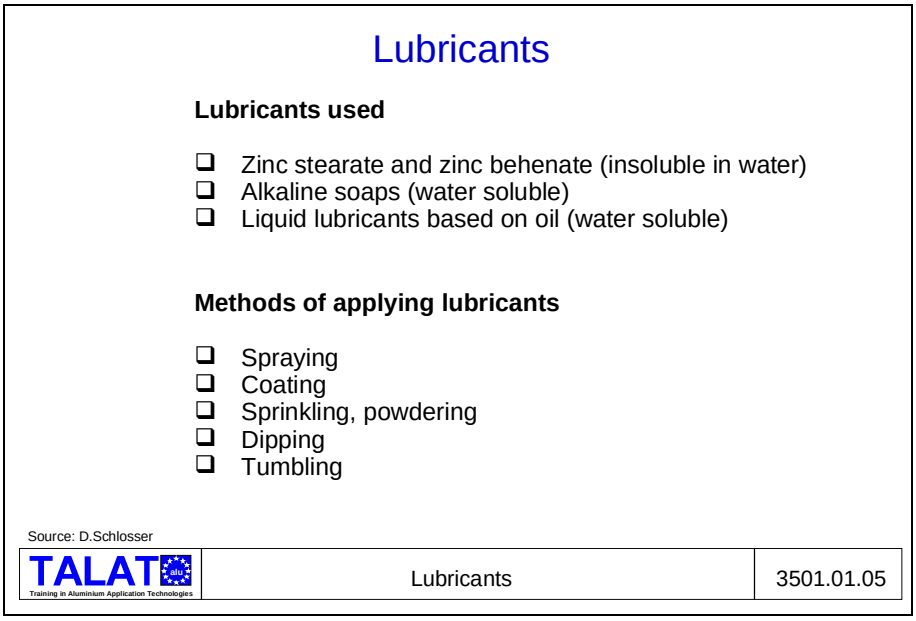
Lubricants

Figure 3501.01.05 lists the different lubricants used and the methods of applying them. Because of environmental considerations, water-soluble lubricants like alkalinen soaps and liquid lubricants based on oil are being increasingly used. Zinc stearate and zinc behenate have nowadays to compete with

- Lubrimet GTT (Sapilub Ltd. Co. Wangen, Zurich) based on paraffin without chlorinated solvents and heavy metal soaps with optimal solubility in water,
- Glisapal SM-155 (Nußbaum Co., Matzingen), a water-soluble, solvent-free, powdery lubricant based on alkaline soaps, not suitable for anneal degreasing and solvent cleaning,

– and liquid lubricants based on oil, like Bonderlube VP 4404/5 (Chemetall Co., Frankfurt), with sulphur compounds, but free from chloroparaffins and metal organic compounds or
– Multipress 9391 (Zeller and Gmelin Co., Eislingen), a fully synthetic oil.

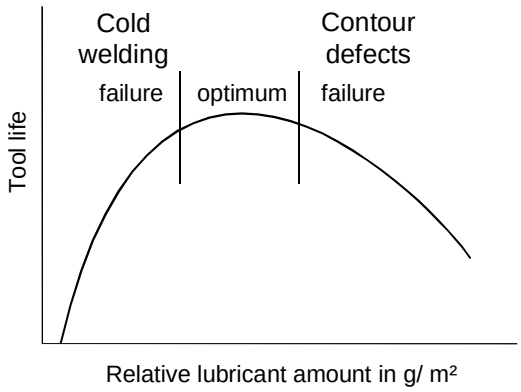
In individual cases, coating layers serving as carriers for lubricants (aluminium, phosphate) are used.



Tool Life as a Function of Amounts of Lubricant

Figure 3501.01.06 illustrates the influence of amount of lubricant used (g/m^2) on tool life. As can be clearly seen, too little or too much lubrication reduces the tool life. If the lubricant used is insufficient, cold welding can occur between tool and work-piece. If too much lubricant is used, then the lubricant accumulation leads to defects in contour replication and to lubricant indentations in the tool. In these cases, the tool has to be cleaned very often. The surface roughness of slugs and blanks has an effect on the tool life. Experiments have shown that smooth slugs reduce the life of tools because the smooth slug surface offers hardly any cavities and pits in which the lubricant can be anchored.

Tool Life as a Function of Amounts of Lubricant



Source: D.Schlosser

TALAT Training in Aluminium Application Technologies	Tool Life and Lubricant Amounts	3501.01.06

3501.02 Literature:

1) F.Ostermann: Technische Kaltfließpreßteile aus Aluminium. In seminar volume "Gestalten und Fertigen von technischen Fließpreßteilen aus Aluminium", Institut für Umformtechnik, Universität Stuttgart, 15.-16. June, 1992

2) D.Schlosser: Einflußgrößen auf das Fließpressen von Aluminium und Aluminiumlegierungen und ihre Auswirkung auf die Weiter- und Fertigbearbeitung der fließgepreßten Rohteile. In seminar volume "Gestalten und Fertigen von technischen Fließpreßteilen aus Aluminium", Institut für Umformtechnik, Universität Stuttgart, 15.-16. June, 1992

3) D.Brix: Kaltfließpressen von Leichtmetall - Qualität und Wirtschaftlichkeit. Draht 1975/5, p. 216-219

4) VDI-Richtlinie 3138: Kaltfließpressen von Stählen und Nichteisenmetallen, Grundlagen, part 1. Beuth-Verlag, Berlin, 1970

5) Aluminium-Zentrale e.V., Report No. 29 "Aluminium für technische Fließpreßteile", Düsseldorf, 1982

3501.03 List of figures

Figure No.	Figure Title (Overhead)
3501.01.01	Aluminium Alloys for Impact Extrusion
3501.01.02	Reference Values for the Strength of Impacts
3501.01.03	Flow Curves and Flow Stresses
3501.01.04	Raw Materials; Blanks and Slugs
3501.01.05	Lubricants
3501.01.06	Tool Life and Lubricant Amounts