“Mircea cel Batran” Naval Academy Scientific Bulletin, Volume XV – 2012 – Issue 2
Published by “Mircea cel Batran” Naval Academy Press, Constanta, Romania

MATERIALS AND BLANKS USED ON DEEP-DRAWING PROCESSING

Aurelia CHIOIBAŞ [1]
[1]eng. PhD, Naval Academy „Mircea cel Batran”, Constanta, Romania

Abstract: *Cold plastic deformation processing provide complicated parts, high precision, a reduced consumption obtained materials. Materials subjected to such processing may be ferrous and non-ferrous. They are characterized by a high plasticity conferred by chemical composition and structure. Increasing the carbon content or of alloying elements decreases plasticity steels. Maintaining the close limits of chemical elements resulting from the elaboration or killing steel leads to increased plasticity them. In the category of non-ferrous materials, Al and Cu alloys are designed especially these processing methods. The blanks used must be characterized by a very good surface quality and dimensional accuracy.*
Keywords:*deep-drawing, the blank, state of hardening.*

1. INTRODUCTION

The cold pressing technological processes confer advantage of obtaining complicated parts with thin walls, which can not be by other processes as well various forms functional constructive with a low of material in terms of ensuring a high accuracy [13].

2. CHARACTERIZATION OF MATERIALS FOR PROCESSING BY COLD FORMING

Metallic materials are generally used as sheets, strips, rods, wires, pipes, profiles. Some of these materials are delivered with varying degrees of hardening, such as soft (annealed), quarter hard, half hard and hard, and some alloys: hardened and naturally aged and artificially [2].

For the material to correspond point of view constructive-functional must be taken into account: chemical composition, mechanical strength, wear resistance, corrosion resistance, thermal conductivity, etc. To meet the technological point of view, the material will have to be examined after composition, microstructure, physical and mechanical properties, dimensional accuracy, surface quality [6].

In order to realize economic analysis will take into account the weight of the piece and consumption of material, cost, and power consumption necessary to obtain parts studied [11].

Metals and alloys are subjected to processing by forming crystalline bodies. Metals and metallic compounds that are formed in the alloy crystallizes mostly in systems centered volume cubic (CVC), with sides centered cubic (CFC), hexagonal ([3], [13]). The metals which crystallize in CVC (α Fe, Cr, V, Mo, W Nb, Ta, etc.) are characterized by high strength and moderate plasticity. The metals which crystallize in CFC (γ Fe, Ni, Pb, Al, Cu, Ag, Au, etc.) have a very good ductility and malleability. The metals which crystallize in the hexagonal system as Zn, Mg, Co, Cd, Be, Zr, Ti has a low plasticity. The plastic deformation is influenced by the maximum atomic density planes. Therefore, the structure of CVC, the maximum density planes of atoms are notated {110} and containing two lines of maximum density (Fig. 1), the maximum density planes of atoms for CFC structure are notated {111} and containing three directions density the maximum (Fig. 2), for hexagonal structure the maximum density planes of atoms are notated {0001} and correspond to the two bases, containing three lines of maximum density (Fig. 3). CFC structure is observed so that best meets plasticity.

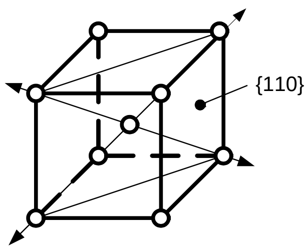

Figure 1: The elementary cell in the system CVC

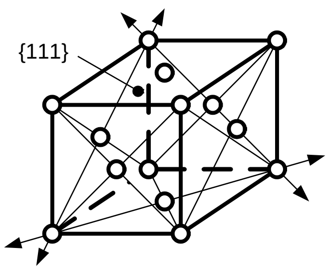

Figure 2: The elementary cell in the system CFC

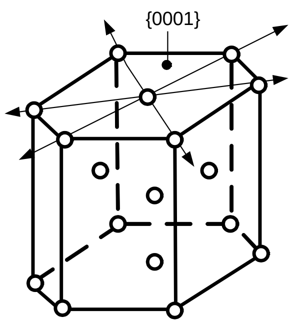

Figure 3: The elementary cell in the hexagonal system

Plastic deformation assumed displacement of atoms, followed by the occupation of new stable equilibrium positions. This is achieved through two mechanisms: slip and twinning. Slip is achieved when the shear stress reaches the critical value and therefore atoms will move along the slip plane (a distance of approximately 1,000 interatomic distances) so that the sample surface will relieve slide. Slip is produced on other neighboring parallel planes, forming slip bands. In CFC system the slip occurs at lower stress, while in the CVC system this is achieved at higher stress. In CFC system shaped rectilinear slip bands (Fig. 4a), while the wavy shaped in CVC system (Fig. 4b), this is explained by the fact that when the slip is braked in some plane, it is easily done on other planes [8]. In case of twinning there is an orientation symmetrical (mirrored) of the crystal lattice relative to the twinning plan. The deformed is called twin crystal (Fig. 5 [8]). This mechanism is found most often in metals which crystallize in the hexagonal system or in CVC. Twinning generally accompanies and promotes slippage.

Figure 4a:The slide in the system CVC

Figure 4b: The slide in the system CFC

Figure 5: Twinning

3. FERROUS AND NONFERROUS MATERIALS USED IN PROCESSING THE PLASTIC DEFORMATION

In the category of ferrous materials, steels can be processed by cold deformation. Increasing carbon content recorded increasing mechanical strength characteristics and reduces the of plasticity and hardening curves (σ_{real} - ε, σ_{real} - ψ) are increasingly located above [13].

Alloying elements generally have an adverse effect on plasticity, increasing resistance to deformation and consequently decrease deformation degree [7].

Nonmetallic inclusions leads to the formation of microcracks, which are primers breaking during processing or exploitation deep-drawing parts. The content of Si, S, P, N and O to be kept very close limits because negative influences plasticity steel ([9], [10]). Homogeneity of the material leading to the registration of homogeneous deformation [12]. For good at deformation behavior is recommended that the material be uniform structure ferrite or ferrite-pearlitic [7]. A significant importance has texture material, which means all crystallographic orientations of grains. Its changes can translated into a change in the coefficient of anisotropy, which means a certain value of resistance to thin sheet for further deformation [5].

For car body parts is recommended killed-steel, deoxidized with Al or Ti. To prevent the appearance of superficial cracks or inadequate appearance of thin sheet surface, they are subject to levelling (cold rolling rolling machines equipped with several special cylinder after which ensures a reduction in thickness by about 2%). Table 1 shows some steel seals for cold forming [13]

Table 1. Ferrous materials as sheet and strip for cold forming processing

Nr.	The blank		The material/ STAS	The thickness, g [mm]
	Name	STAS		
1	Tinplate	900	pickled sheet	g = 0,22...0,6
2	Narrow strip cold rolled carbon steel	1945	OL32/STAS 500	g = 0,3….3,5
3	Hot rolled strip	908	OL500; OLC880	g = 2….5
4	Wide strips of hot rolled steel in rolls	9236	OL500; OLC880; deep-drawing steel/ STAS 9485, etc.	g = 3….12
5	Black sheet	1946	OL32; OL34/ STAS 500	g = 0,25….1
6	Galvanized sheet	2028	OL32; OL34/ STAS 500	g = 0,3….4
7	Cold rolled steel strip	7655	Spring steel / STAS 795	g = 0,2….2,2
8	Wide strips cold rolled steel	9150	carbon steel / STAS 9485; 9724; 10318	g = 0,3….3
9	Sheet and strip for deep drawing	9485	carbon steel / STAS 9485	g = 0,5….2
10	Thin sheets of cold rolled steel	9624	According STAS 9485; 9724; 10318	g = 0,4….3,5

The plastic deformation can process a wide range of nonferrous alloys, taking into account their chemical composition and microstructure.

Thus, brass (Cu-Zn alloys) is characterized by good plasticity cold which increases with Zn content up to 30-32%. Good plasticity corresponds to α-phase domain (substitution solution of zinc in the copper) from equilibrium diagram because crystal lattice type face centered cube has the largest deformation capacity [3]. Alloying elements or accompanying such as Fe (> 0.1%), Pb (> 0.03%), Bi (> 0,003%), Sb (> 0,005%), As (> 0.03%), P (> 0,005%), S (> 0.002%), considerably worse plasticity in particular through the formation of chemical components hard and brittle as: Cu_2Sb, Cu_3As, Cu_3P, and others [4].

Cu-Ni-Zn alloys, called German-silver, containing 55-65% Cu, 15-18% Ni, 17-27% Zn. Most commonly used alloy is characterized by a single phase structure and contains 15% Ni + 20% Zn + rest. These alloys have high corrosion resistance, very good plastic forming and a very nicely.

Technical aluminum (99.9 to 99.5% Al), which crystallize in the face centered cubic system and aluminum alloys have good deformability. Impurities such as Fe, Si, Sn, Pb lead to decrease plasticity. Adding small quantities Mn, Cr, Ti, V increases corrosion resistance, mechanical resistance of aluminum alloys and give them a good plasticity.

Table 2 shows some marks nonferrous alloys used in processing by cold pressing.

4. MATERIALS AND BLANKS FOR USE IN THE SMALL AND MEDIUM-SIZED PIECES OF BAND DEEP DRAWING SUCCESSIVE

ArcelorMittal Galati provide thin narrow strips of low carbon, g = 0.07 ... 3mm thickness and width l = 10 ... 295mm (narrow ones are obtained by cutting cold rolled strip width of 300mm) [1]. Depending on the brand, the main areas of application are: A2, bending and deep-drawing cold, moderate deformation, in the car industry, household, A3, for deep drawing cold with average degree of deformation in the industry vehicles, agricultural machinery, household goods, electronics industry and other fields, A5, for deep drawing very deep in the the automotive industry and other fields.

Surface quality is assessed as follows: matte surface, where Ra ∈ (1.2 ... 1.8) μm, surface gloss, if Ra max = 1,2 mm, high gloss surface, where Ra max = 0.6 ìm. Depending on the nature and dispersion admissible surface defects, sheets can be included (in ascending order of quality) in the groups: 0.2, 0.3, 0.4, and 0.5.

Materials can be delivered in the the following states: soft (m) ¼ hard (1/4T) ½ hard (1/2T) ¾ hard (3/4T) ¾ hard-special (3/4T-S) hard (T).

Table 2. Nonferrous materials as sheet and strip for cold forming processing by

Nr	THE BLANK		*THE MATERIAL/ STAS*	The thickness , g [mm] The diameter, d [mm]
	NAME	S TAS		
1.	Sheets of copper-zinc alloys	289	CuZn10; CuZn15; CuZn20; CuZn30; CuZn31Si; CuZn36/ STAS 95	g = 0,5…5
2.	Copper-zinc alloy strips	290	CuZn10; CuZn15; CuZn20; CuZn30; CuZn36/ STAS 95	g = 0,1..2
3.	Sheets of copper	426	Cu 99,97; Cu 99,95; Cu 99,9	g = 0,5…5
4.	Copper strips	427	Cu 99,97; Cu 99,95; Cu 99,9	g = 0,1…2
5.	Sheets of aluminum	428	Cu 99,97; Cu 99,5; Cu 99/ STAS 7607	g = 0,3…5
6.	Sheets of zinc and aluminum alloys	488	Cu 99,99; Cu 99,985; Cu 98,5/ STAS 646	g = 0,3…6
7.	Sheet and strip alloy Cu-Ni-Zn-(German silver)	1178	Current CuNi18Zn27 / STAS 1096 and other brands as STAS 1178	Sheet metal: g = 0,5…5 Strip: g = 0,1…2,5
8.	Copper discs	2673	Cu 99,97; Cu 99,95; Cu 99,9/ STAS 270	g = 0,8; 1; 1,5 d = 200…650
9.	Copper-zinc alloy discs	2674	CuZn 36/ STAS 95	g = 0,8; 1; 1,5 d = 200…650
10.	Disks of aluminum	2675	Al 99,5; Al 99/ STAS 7607	g = 0,4…10 d = 50…1000
11.	Strips of aluminum	5681	Al 99,7; Al 99,5; Al 99/ STAS 7607	g = 0,1…3
12.	Strips of aluminum, copper and copper-zinc alloys (brass)	8633	Al 99,5/ STAS 7607; Cu 99,9/ STAS 270	Al:g = 0,2…0,8 Cu:g = 0,1…0,8 CuZn: g = 0,1…1,35

Band edges can be cut (MT) or uncut (natural) (MN). If MT bands check straightness and curvature arrow must not exceed 3 mm / m.

Deviations from the thickness can be class "N" (normal), "F" (fine) and "P" (accurate) to wide deviations are given separately for MT and MN bands and their values are listed in STAS 6925 / 2-89 [14].

Cold rolled strip symbol include: material quality, appearance group surface roughness class, g·l, sorts edges, limited tolerance class, state of hardening, standard company.

Mechanical characteristics (σ_r, σ_c, A_{80}) for all brands, hardening corresponding to each state are shown in Table 3, and the chemical composition in Table 4. Bands in the state of hardening soft annealed and cold-rolled are delivered with grain size 6-9 score, according to STAS 5490-80.

Table 3. Mechanical characteristics of the bands drawing from ArcelorMittal

Mark steel	Rate deoxidation	C	Al	Mn	Si	P	S
A_2	steel acid process	0,15	-	0,5	0,05	0,045	0,045
	steel killed	0,13	0,08				
A_3	steel acid process	0,13	-	0,45	0,05	0,035	0,04
	steel killed	0,11	0,08				
A_5	steel killed	0,08	0,08	0,4	0,1	0,025	0,03

Table 4. The chemical composition of the bands drawing from ArcelorMittal

Mark steel	State hardening	σ_c [N/mm^2]	σ_r [N/mm^2]	A_{80} [%] min.
A2(A3,A5)	m	220	270-340	30
A2(A3)	1/4 T	280	340-470	10
A2(A3)	1/2T	350	410-550	4
A2(A3)	3/4T	450	500-640	-
A2(A3)	T	500	min.600	-

SC Galfinband S.A. Galati delivers A3K-M bands (hardening soft state) and A5 ([15], [16]) having the chemical composition shown in Table 5 and mechanical characteristics presented in Table 6 [1].

Table 5. Chemical composition A3K-M and A5 bands from Galfinband

Mark steel	Rate deoxidation	C	Al	Mn	Si	P	S
A3K-M	steel killed	0,05	0,047	0,26	0,02	0,012	0,013
A5	steel killed	0,015	0,056	0,26	0,01	0,018	0,013

Table 6. Mechanical characteristics A3K-M and A5 bands from Galfinband

Mark steel	Tensile testing		
	N / mm^2		A_{80} [%]
	R_m	$R_{p0,2}$	
A3K04-M	359	270	36,6
A5	312	220	43,5

Another common material is subjected to processing by drawing alloy CuZn30-A [17] (hardening soft state), whose chemical composition is given in Table 7, and mechanical characteristics in Table 8.

Table 7. The chemical composition of the brass band CuZn30-O

The alloy	Cu	Pb	Fe	Mn	Al	Sn	As
CuZn30-O	68,5-71,5	0,05	0,1	0,05	0,02	0,05	0,02-0,06

Table 8. Mechanical characteristics of CuZn30-O brass band

Mark alloy	Brinell hardness	Tensile testing	
		R_m [N / mm^2]	A[%]
CuZn30-O	70 HB	274-353	45

Quality conditions require CuZn30-O band area is clean, smooth, no raised, cracks, scales, stratification, superposition material inclusions. Rough are permitted accidental rolling scores or superficial marks, provided that the thickness is greater than the minimum allowable. Bands delivered soft state (symbol "O") should be a mat obtained from pickling. Are admitted from pickling local dimming and color of aging during storage material. Roughness must have values in the range (1.2 - 1.8) μm, either by the arithmetic mean deviation of the profile Ra.

5. CONCLUSIONS

Materials for processing by drawing can be ferrous or nonferrous. They should be characterized by a very good plasticity conferred by the chemical composition and structure, dimensional accuracy and surface quality. Their choice is based on the characteristics of strength, wear and corrosion imposed by the use of parts.

6. BIBLIOGRAFY

1. Chioibaş A. *Cercetări privind influenta conditiilor de deformare asupra calităţii pieselor ambutisate,* Teză de doctorat, UPB, 2004
2. Ciocîrdia C., ş.a. *Tehnologia presării la rece.,* Editura Didactică şi Pedagogică, Bucureşti, 1991
3. Colan H., ş.a. *Studiul metalelor ,* Editura Didactică şi Pedagogică, Bucureşti, 1980
4. Groza I., ş.a. *Deformarea plastică a metalelor şi aliajelor neferoase,* Editura Tehnică, Bucureşti, 1977
5. Grumbach M., ş.a. *Méthodes d'études des textures des tôles minces,* Mémoires Scientifiques Revue Métallurgie, 72, nr. 3(1975), p. 241- 252
6. Iliescu C. *Tehnologia presării la rece,* Editura Didactică şi Pedagogică, Bucureşti, 1984
7. Kiessler H., Fröber H. *Materiale destinate deformării plastice la rece,* Werkstattstechnik, nr.2, februarie 1971, RFG, p. 112 - 119
8. Mantea, Şt., ş.a. *Metalurgie fizică,* Editura Tehnică, Bucureşti, 1970
9. Pîrvu G. *Corelaţii între textura cristalografică şi deformabilitatea benzilor subţiri pentru ambutisare, determinată cu ajutorul coeficienţilor de ecruisare şi anizotropie normală,* Metalurgia, 30 (1978), nr. 9, p. 497-501
10. Reinhold L. *Ecruisarea şi exponentul de ecruisare al oţelurilor,* Werkstatt und Betrieb 121, (1971), nr. 8, RFG, p. 533-540
11 Teodorescu M. *Cercetări privind prelucrabilitatea prin ambutisare în vederea reducerii consumului de metal şi energie*, Metalurgia, 38 (1986), nr. 12, p. 609-613
12 Teodorescu M. *Contribuţii la studiul prelucrabilităţii prin ambutisare*, Journal of Plastic Deformation, 1993, p. 11-16
13 Teodorescu M., ş.a. *Prelucrări prin deformare plastică, vol. I, II,* Editura Tehnică, Bucureşti, 1987
14 *** *STAS 6925/2 - 89*
15 *** *Ofertă generală, Galfinband S.A.*
16 *** *Standard de firmă, S.F.558-96*
17 *** *STAS 95/87*