

VIII/2C Metal Forming Data

Part 2: Non-Ferrous Alloys

Contents

	Overview of Light Metal Alloys with page number references	1
1	Definitions and Test Methods	4
1.1	Flow stress	4
1.2	Plasticity	5
1.3	Deformation behaviour	6
1.4	Methods to determine the deformation behaviour	8
1.4.1	Overview and specifications	8
1.4.2	Test methods for simulation	11
1.4.3	Technological tests	17
1.4.3.1	Deep drawing test	17
1.4.3.2	Rolling test	19
1.5	References	21
2	Flow stress	22
2.1	Influence of the chemical composition	22
2.1.1	Hot working	22
2.1.1.1	Basic relationships	22
2.1.1.2	Experimental and commercial materials	24
2.1.2	Cold working	30
2.1.2.1	Basic relationships	30
2.1.2.2	Influence of treatment conditions	30
2.1.2.3	Initial structure	34
2.2	Influence of forming conditions	36
2.2.1	Hot forming	36
2.2.1.1	Influence of the deformation temperature	37
2.2.1.2	Influence of strain	37
2.2.1.3	Influence of the strain rate	40
2.2.2	Cold forming	42
2.2.2.1	Degree of deformation	42
2.2.2.2	Rate of deformation	43
2.2.2.3	Temperature of deformation	44
2.3	Modelling	45
2.3.1	Influence of chemical composition	45
2.3.2	Influence of forming conditions	49
2.3.2.1	Hot working	49
2.3.2.1.1	Modelling by means of the thermodynamic factors	50
2.3.2.1.2	Calculation using the activation energy of hot deformation	52
2.3.2.2	Cold deformation	55
2.3.2.2.1	Effect of the degree of deformation	55
2.3.2.2.2	Influence of degree of deformation, deformation temperature and deformation rate	58
2.4	References	59

3	Plasticity	61
3.1	Hot plasticity	61
3.1.1	Influence of the material	62
3.1.2	Material condition	63
3.1.3	Influence of temperature and strain rate	64
3.2	Cold plasticity	66
3.2.1	Factors influencing cold plasticity	66
3.2.2	Parameters of cold plasticity	66
3.2.3	Influence of the material	67
3.2.4	Temperature	68
3.2.5	Strain rate	69
3.2.6	Influence of the stress condition	71
3.3	Modelling of the plasticity in hot working	71
3.3.1	Modelling of the influence of the chemical composition	71
3.3.2	Influence of deformation conditions	73
3.3.2.1	Modelling of temperature influence	73
3.3.2.2	Modelling of the influence of strain rate	75
3.4	Calculation of the forming limit in hot rolling	76
3.5	Calculation of the forming limit in hot extrusion	79
3.6	References	81
4	Mechanical and physical properties	82
4.1	Mechanical properties after cold forming	82
4.1.1	Yield point and tensile strength	82
4.1.2	Elongation	83
4.2	Young's modulus	84
4.2.1	Definition and functional relationships	84
4.2.2	Modelling of the temperature dependence of Young's modulus	86
4.3	Thermal conductivity	87
4.3.1	Basic data	87
4.3.2	Calculation of the thermal conductivity	89
4.4	Specific heat	93
4.4.1	Experimental data	93
4.4.2	Calculation of the specific heat	94
4.5	Coefficient of the thermal expansion	96
4.5.1	Definition and factors of influence	96
4.5.2	Influence of temperature on the coefficient of thermal expansion	97
4.6	Density	99
4.6.1	Definition and factors of influence	99
4.6.2	Modelling the dependence on temperature	99
4.7	References	102
5	Data bank of deformation parameters	102
5.1	Introduction	102
5.1.1	Basis of the data bank	102
5.1.2	Hot and cold flow curves	102
5.1.2.1	Remarks on the data of flow stress	103
5.1.2.2	Extrapolation	103
5.1.3	Plasticity curves	104
5.1.4	Mechanical and physical properties	105
5.2	Beryllium	107
5.3	Magnesium and Magnesium Alloys	110
5.3.1	Magnesium	110

5.3.2	Magnesium-Aluminium Alloys	123
5.4	Aluminium and Aluminium Alloys	175
5.4.1	Unalloyed Aluminium	175
5.4.2	Aluminium-Copper and Aluminium-Copper-Magnesium Wrought Alloys	199
5.4.3	Aluminium-Manganese, Aluminium-Magnesium-Manganese and Aluminium-Silicon Wrought Alloys	233
5.4.4	Aluminium-Magnesium and Aluminium-Magnesium-Manganese Wrought Alloys .	282
5.4.5	Aluminium-Silicon-Magnesium, Aluminium-Magnesium-Silicon, Aluminium-Zinc-Magnesium and Aluminium-Zinc-Magnesium-Copper Wrought Alloys	342
5.4.6	Wrought Aluminium Alloys with other main constituents	414
5.5	Titanium and Titanium Alloys	433
5.6	References	474