

Contents

Summary	7
Streszczenie	9
The list of main symbols	11
1 State of the art in inverse analysis of metal forming	13
2 The thesis and the structure of the book	20
2.1 The thesis and the objectives of the work	20
2.2 The structure of the book	21
3 Inverse problems. The mathematical background	23
3.1 Modeling of metal forming processes	23
3.2 Inverse problems for the thermomechanical deformation problem	26
3.3 General formulation of the inverse problem	26
3.4 Regularization	29
3.5 Methods of regularizations	30
3.5.1 Tikhonov regularization	32
3.5.2 Iteration methods	33
3.5.3 Regularization by projection	36
3.6 Numerical computation	37
3.6.1 Regularization in the finite dimension setting	38
3.6.2 Practical aspects and problems	39
4 Sensitivity analysis	41
4.1 Local sensitivity analysis	42
4.1.1 A scheme for semi-analytical sensitivity calculations	44
4.1.2 An optimization algorithm enriched with sensitivity analysis .	45
4.2 Global sensitivity analysis	49
4.2.1 An algorithm based on the Morris design	53
4.2.2 Variance based methods	56
4.3 The implementation of sensitivity analysis algorithms	61
5 A strategy for the identification of the model parameters	63
6 Case studies	66
6.1 Rheological and friction models	67
6.1.1 Objectives of the work	67
6.1.2 The experiments	68

6.1.3	The numerical model of the plastometric test	70
6.1.4	The identification task	77
6.1.5	The estimation of the functional minimum	78
6.1.6	The results of the parameter identification	83
6.1.7	Sensitivity analysis	88
6.1.8	Discussion of the results	95
6.2	A quantitative fracture criterion	96
6.2.1	Objectives of the work	97
6.2.2	The experiment	97
6.2.3	A numerical model of the SICO test	98
6.2.4	Sensitivity analysis	99
6.2.5	Discussion of the results	101
6.3	The strain localization model	102
6.3.1	Objectives of the work	102
6.3.2	The experiment	102
6.3.3	The numerical model of a shearing test	103
6.3.4	Sensitivity analysis	104
6.3.5	Discussion of the results	107
6.4	The phase transformation model	107
6.4.1	Objectives of the work	108
6.4.2	Phase transformation models	108
6.4.3	Sensitivity analysis	112
6.4.4	Identification of the model parameters	115
6.4.5	Discussion of the results	116
6.5	Design of the hot rolling technology of dual phase steel strips	117
6.5.1	Objectives of the work	118
6.5.2	The experiment	118
6.5.3	The numerical model of the process	119
6.5.4	Sensitivity analysis	120
6.5.5	Discussion of the results	122
6.6	Design of the continuous annealing process	123
7	Conclusions	128
7.1	Summary	128
7.2	Future prospects	130
A	Functional analysis - fundamentals	133
Bibliography		136