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Study on Influence of Process Parameters to Superplastic Forming from AA7075 Aluminum Alloy Sheet

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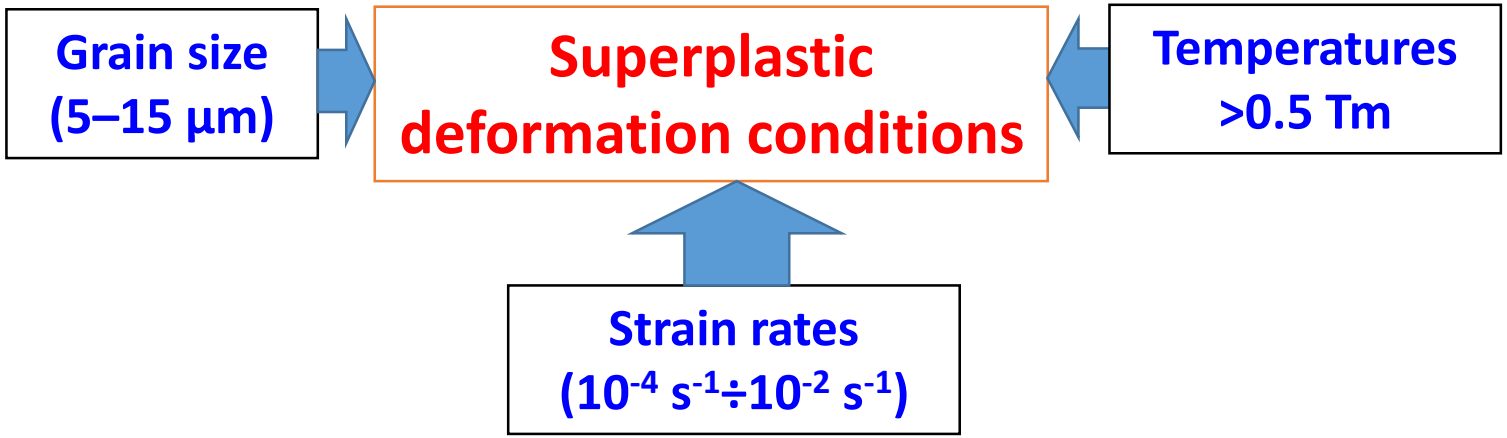
1. Introduction

Superplasticity is the ability of materials to deform plastically with large tensile strains before failure when they are deformed under a limited conditions.

Figure 1



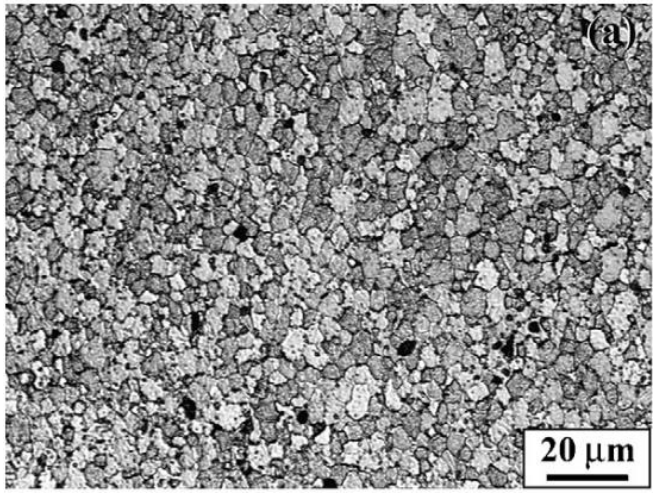


Figure 2

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1. Introduction

Applications of superplastic forming: aerospace industries, auto industries, flying equipments, weapons, arts and etc.

Aluminium alloy 7075 is high strength alloys. It is among the most durable alloys in deformed aluminum alloys. Therefore, it is necessary to improve the deformation ability of this alloy.

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1. Introduction

The problem needs research: The goal of paper is to assess the influence of process parameters on superplastic deformation of AA7075 alloy sheet. The parameters considered include forming pressure (0.7 – 0.9MPa), deformation temperature (500 - 530^{0}C) and forming time (20 – 40 minutes), while the response is the relative height of the product (H).

The results of this work allow us to understand:

- ❑ The relative height of the product increases with increasing pressure, temperature, and forming time.
- ❑ However, there exist limit values of forming time, where the law of the influence of temperature and forming pressure on relative height is reversed.
- ❑ Therefore, in each specific machining case, it is necessary to select the range of appropriate process parameters to get the desired results.

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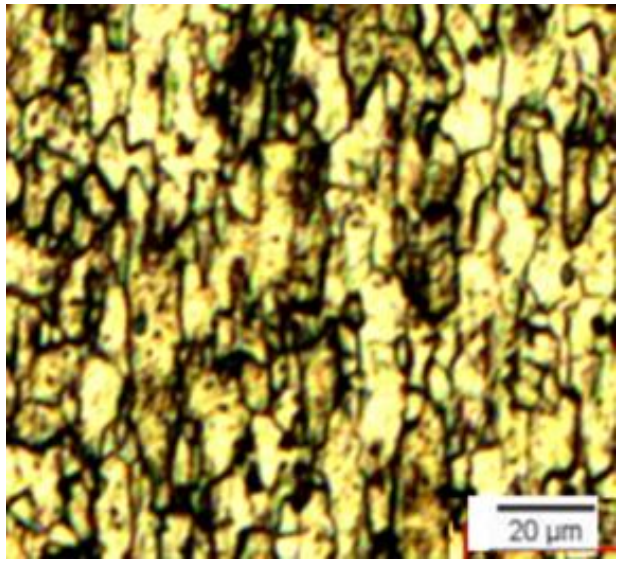
2. Materials and methods

Chemical compositions of the 7075 alloy (wt.%) and mechanical properties.

Zn	Mg	Cu	Fe	Cr	Ti	Mn	Si	Al	σ_b, MPa	δ (%)
5.35	2.34	1.32	0.30	0.22	0.04	0.024	0.05	Balance	550	9.0

The AA7075 alloy sheet is prepared by thermomechanical process with average grain size about 13 μm to meet the SPF conditions. Tensile tests preformed in the SPF condi-tion obtained the greatest relative elongation around 280%



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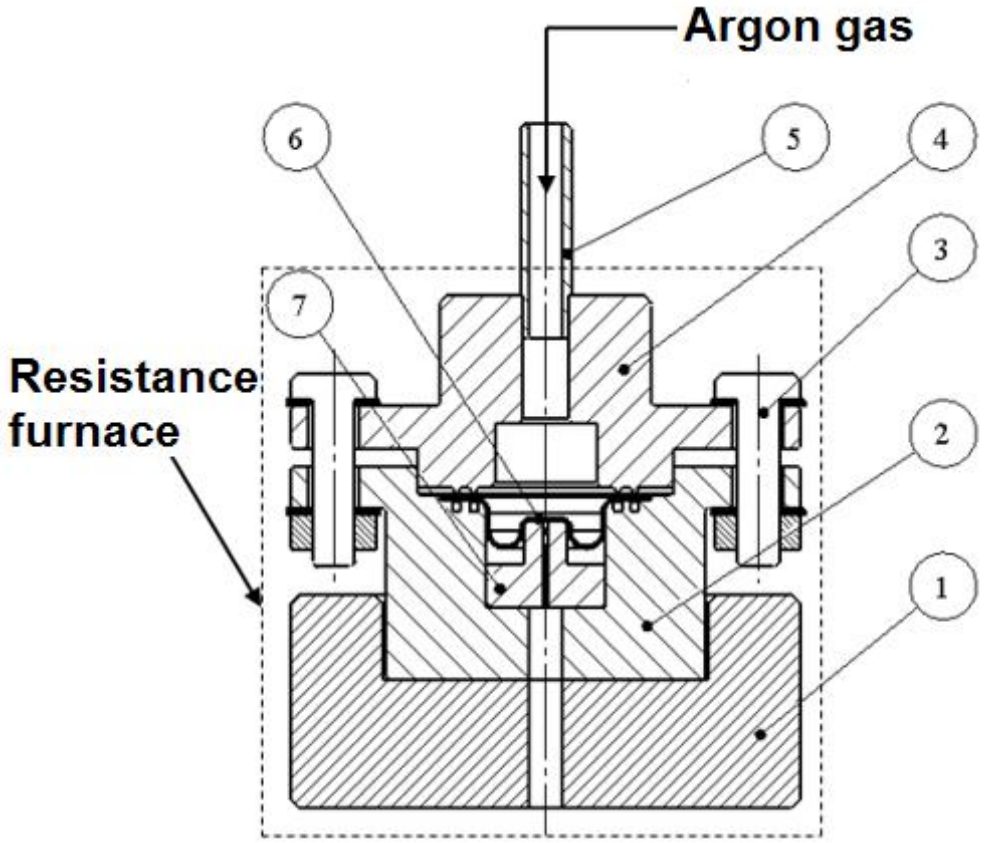
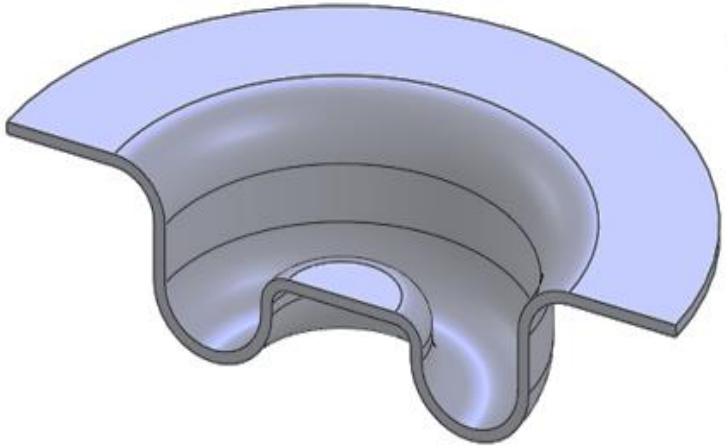
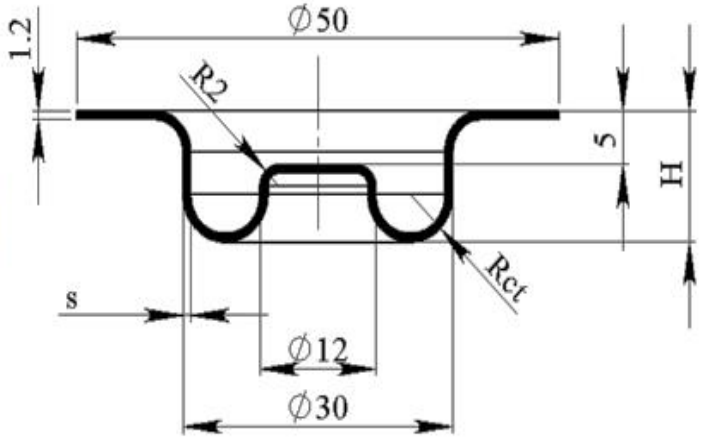
The sheet superplastic forming (SSPF) process:



The SSPF diagram





Cylindrical hollow detail after SSPF

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3. Results and Discussions

The RSM based on a BBD was used to study the influence of process parameters on the SPF ability.

Forming pressure (X1), deformation temperature (X2) and forming time (X3) are the independent variables chosen in this experimental design, the relative height of the product is chosen as objective function (R) for combinations of independent variables.

Levels and their values of the process parameters

Parameters	Level -1	Level 0	Level +1
X1: Forming pressure (MPa)	0.7	0.8	0.9
X2: deformation temperature (^{0}C)	500	515	530
X3: Forming time	20	30	40

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3. Results and Discussions

Results of ANOVA for relative height of product of SSPF

Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model	0.0836	9	0.0093	25.93	25.93	significant
X1-X1	0.0036	1	0.0036	10.08	10.08	
X2-X2	0.0136	1	0.0136	37.99	37.99	
X3-X3	0.0162	1	0.0162	45.21	45.21	
X1X2	0.0006	1	0.0006	1.74	1.74	
X1X3	0.0121	1	0.0121	33.77	33.77	
X2X3	0.0009	1	0.0009	2.51	2.51	
$X1^2$	0.0285	1	0.0285	79.64	79.64	
$X2^2$	0.0103	1	0.0103	28.85	28.85	
$X3^2$	0.0009	1	0.0009	2.45	2.45	
Residual	0.0018	5	0.0004			
Lack of Fit	0.0009	3	0.0003	0.7115	0.7115	not significant
Pure Error	0.0009	2	0.0004			
Cor Total	0.0854	14				
R^2	0.9790					
Adjusted R^2	0.9413					
Predicted R^2	0.8039					
Adeq Precision	15.1235					

The products after SSPF

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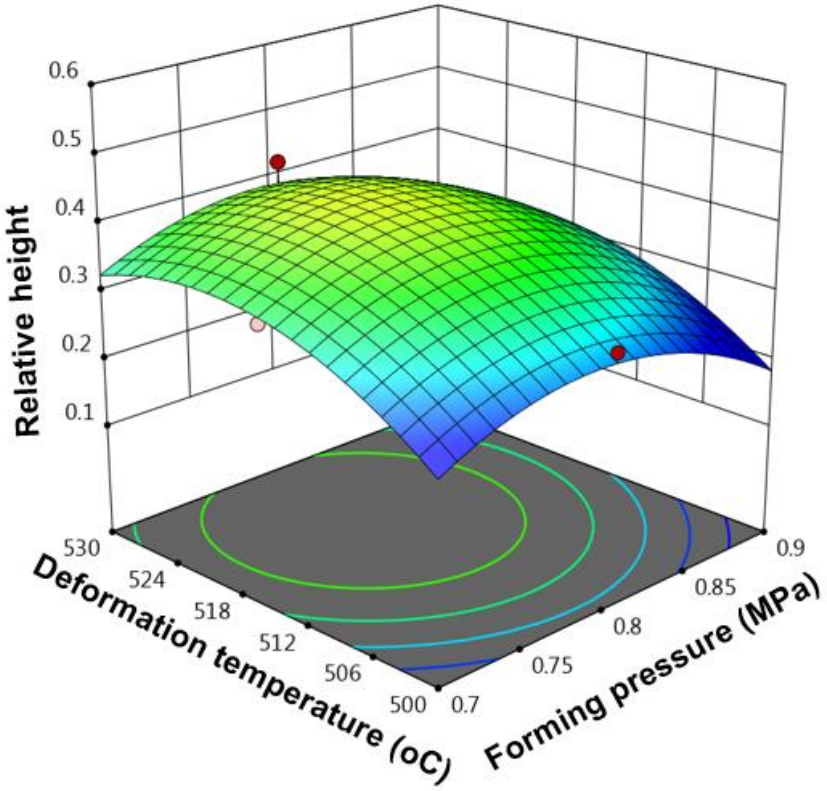
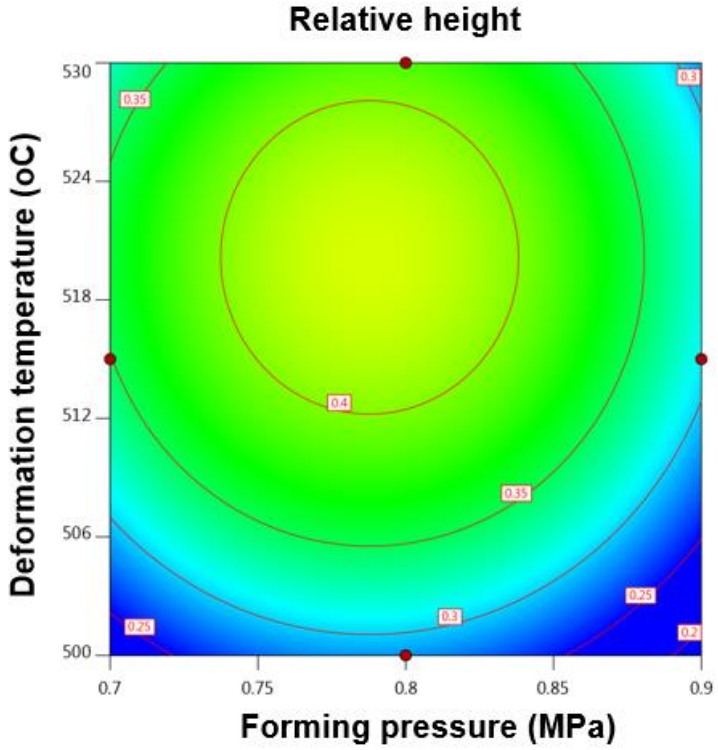
3. Results and Discussions





Response surface plots and contour plots showing the efect of the forming pressure (X1), deformation temperature (X2) on relative height of the product

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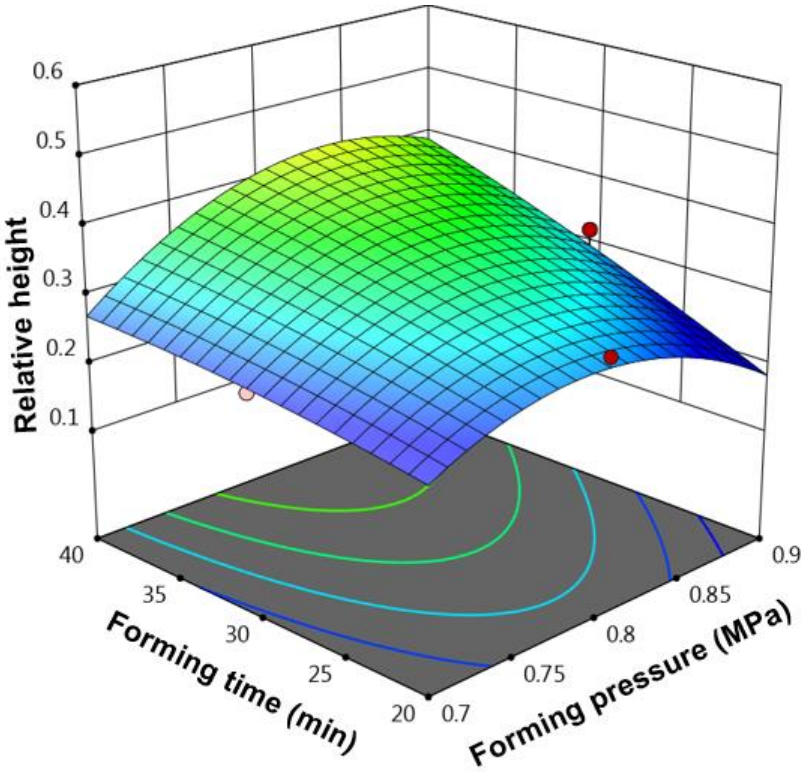
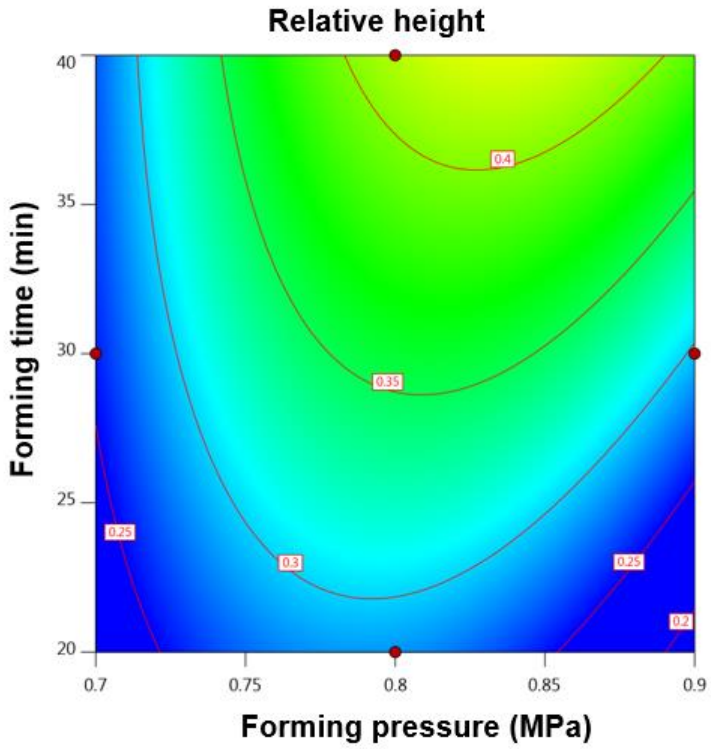
3. Results and Discussions





Response surface plots and contour plots showing the efect of the forming pressure (X1), forming time (X3) on relative height of the product

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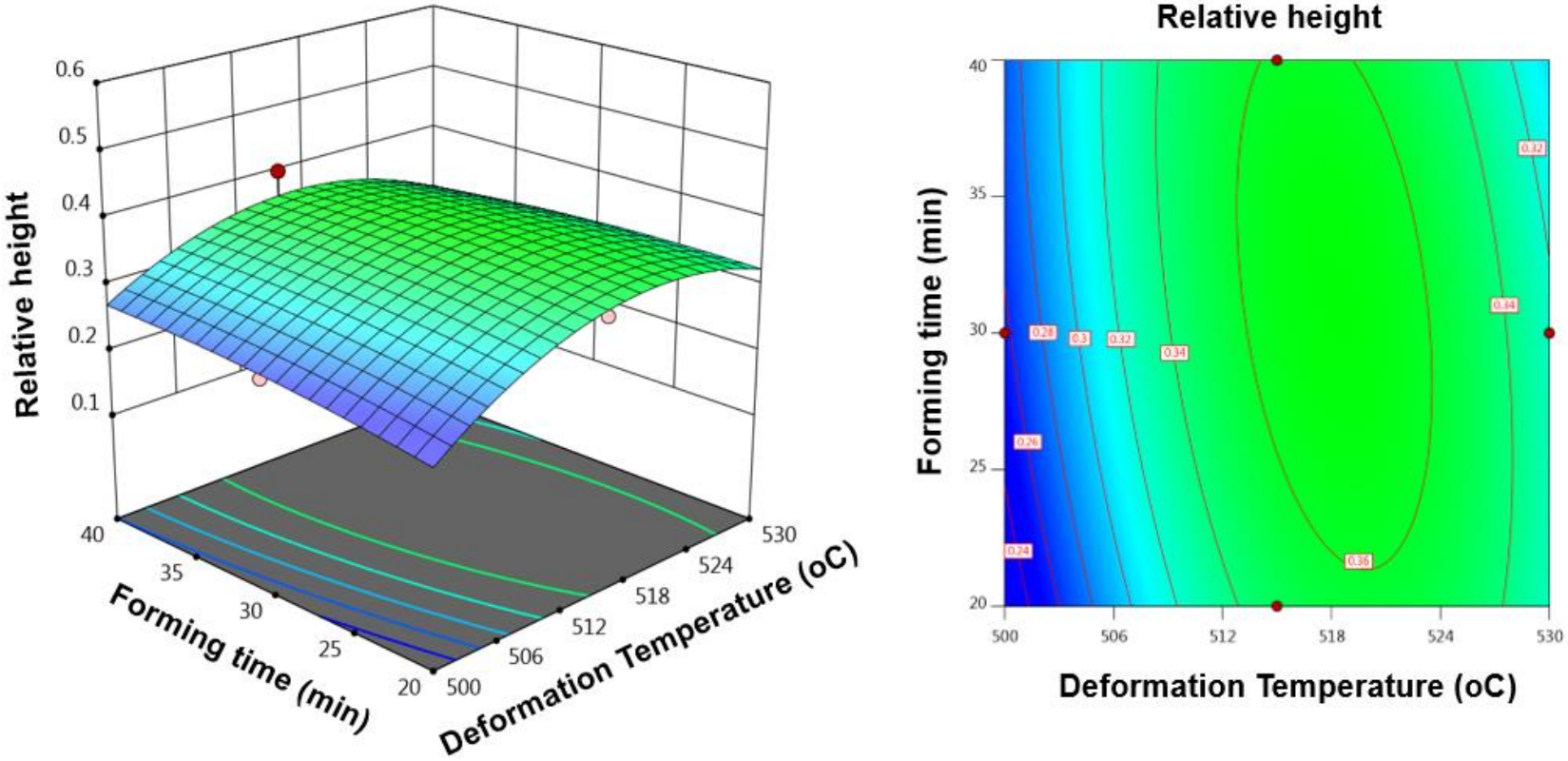

Response surface plots and contour plots showing the efect of the deformation temperature (X2), forming time (X3) on relative height of the product

Study on Influence of Process Parameters to Superplastic Forming from AA7075 Aluminum Alloy Sheet

3. Results and Discussions

- The paper studied the influence of some main process parameters: forming pressure, deformation temperature, and forming time on the relative height of product in SSPF from high-strength aluminum alloy sheet AA7075.
- In the survey area, including forming pressure (0.7÷0.9 MPa), deformation temperature (500÷530°C) and forming time (20÷40 minutes) found that, as the forming pressure, deformation temperature and forming time increased, the relative height of the product increased. However, when the forming pressure or deformation tempera-ture increases to a certain value, the relative height of the product tends to decrease.
- The obtained research results help determine the laws of mutual influence, the influence of the process parameters on the deformation ability in SSPF with complex shapes, thereby recommending the selection of a reasonable set of process parameters in the forming process and actual production, contributing to reducing design and testing time, improving productivity and product quality.

THANK YOU
FOR YOUR ATTENTION!