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Effect of Cyclic Close Die Forging on Microstructure and Mechanical Properties of Ti – 5Al – 3Mo – 1.5V Alloy

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Effect of Cyclic Close Die Forging on Microstructure and Mechanical Properties of Ti – 5Al – 3Mo – 1.5V Alloy

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Effect of Cyclic Close Die Forging on Microstructure and Mechanical Properties of Ti – 5Al – 3Mo – 1.5V Alloy

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

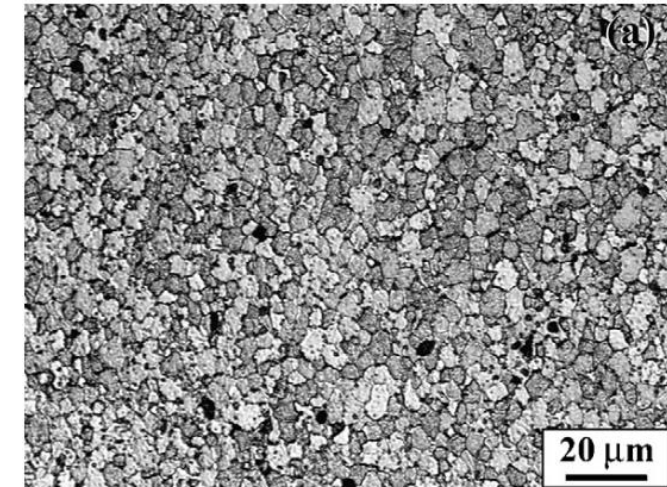
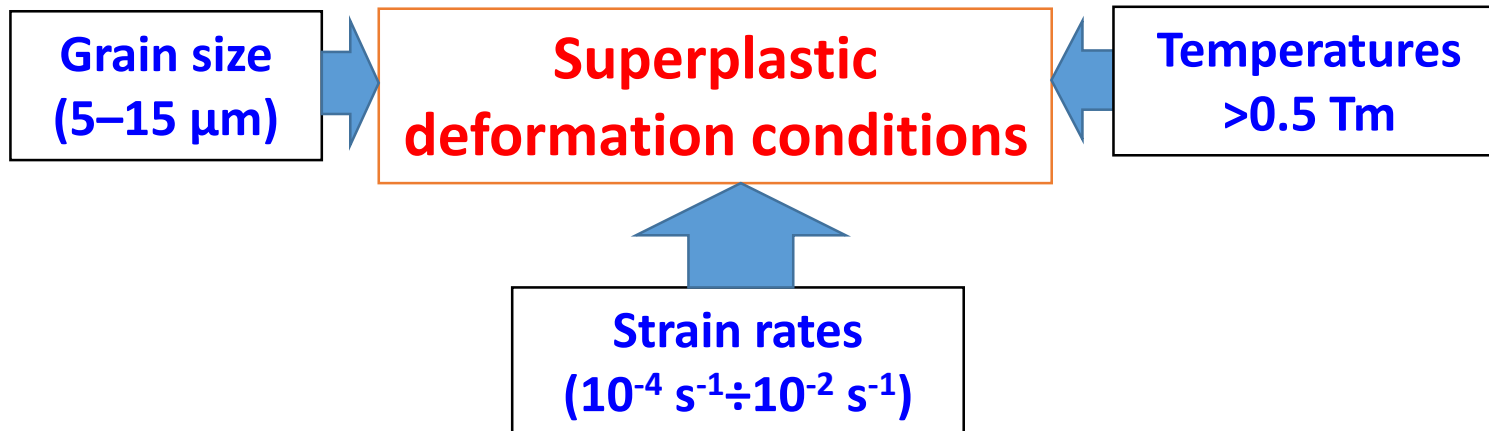


Figure 2

Effect of Cyclic Close Die Forging on Microstructure and Mechanical Properties of Ti – 5Al – 3Mo – 1.5V Alloy

1. Introduction

Titanium alloy is a structural material with many outstanding properties

Titanium alloy is increasingly used in many different technical industries, especially in the aviation, automotive, and defense industries.

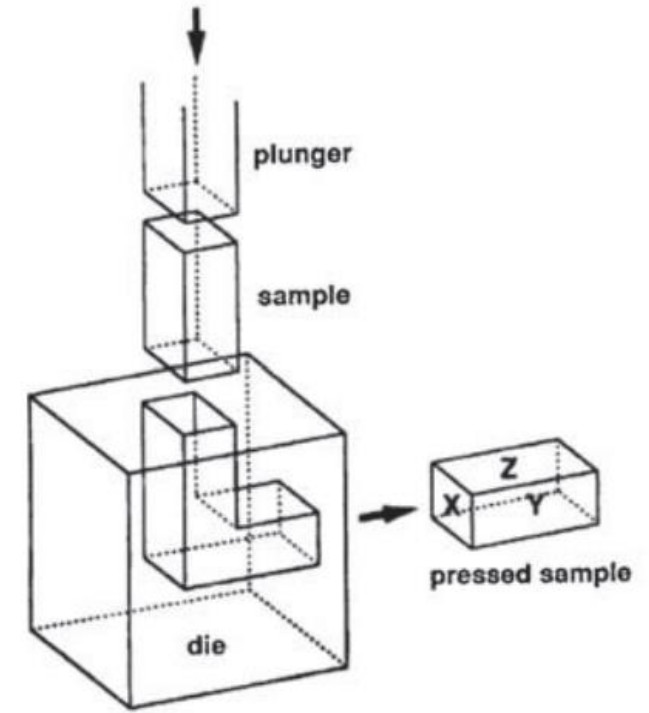
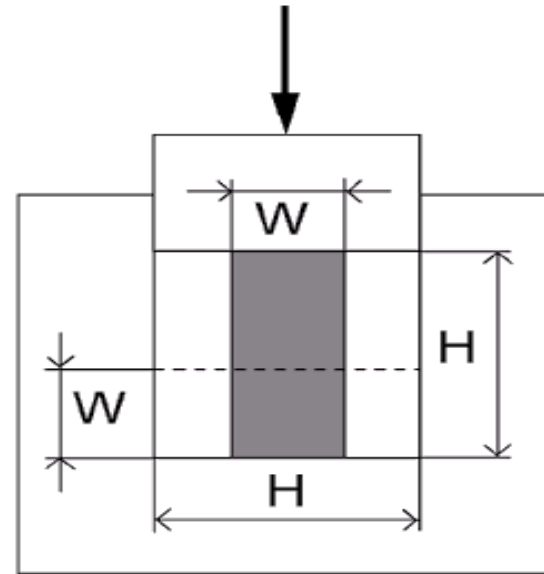
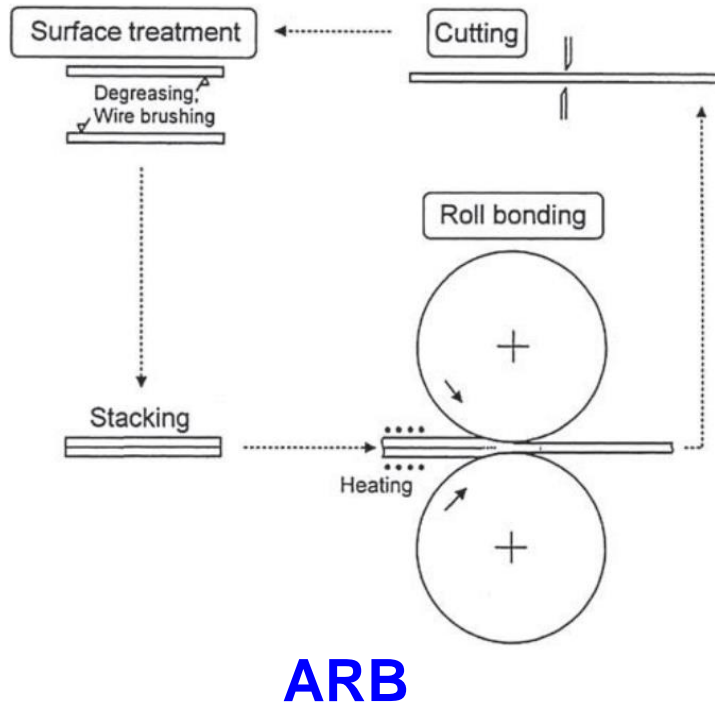
At room temperature, the durability of titanium alloy is very large, making it difficult to cut, so it is usually deformed at high heat in the range from 600 ÷ 1050°C



Effect of Cyclic Close Die Forging on Microstructure and Mechanical Properties of Ti – 5Al – 3Mo – 1.5V Alloy

1. Introduction

The methods that can be used to give the material a fine grain structure is the severe plastic deformation (SPD).



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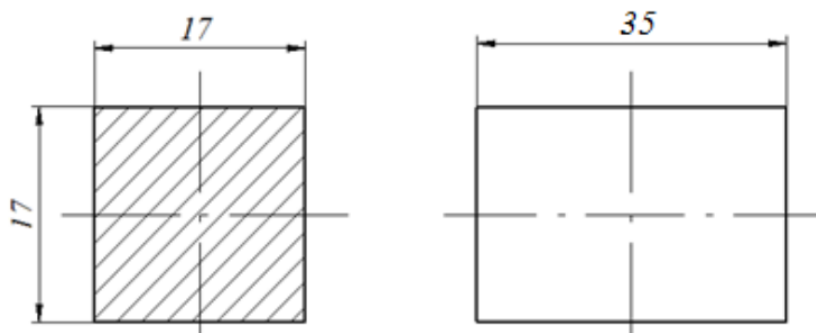
1. Introduction

Objective:

- ❑ Effect of Cyclic Close Die Forging on Microstructure and Mechanical Properties of Ti – 5Al – 3Mo – 1.5V Alloy.
- ❑ Effect of the temperature (between 800 and 900°C) and the number of deformation times (3 to 9 times) on the structure and properties of Ti – 5Al – 3Mo – 1.5V titanium alloy.

Effect of Cyclic Close Die Forging on Microstructure and Mechanical Properties of Ti – 5Al – 3Mo – 1.5V Alloy

2. Experimental procedure



Chemical composition

Element	Al	Mo	V	Zr	Si	Fe	O	N	Ti
Wt%	5.36	3.27	1.54	0.30	0.045	0.152	0.037	0.015	Balance

- ❑ The Ti - 5Al - 3Mo - 1.5V titanium alloy is produced in Vietnam.
- ❑ The test specimens are in the casting state.

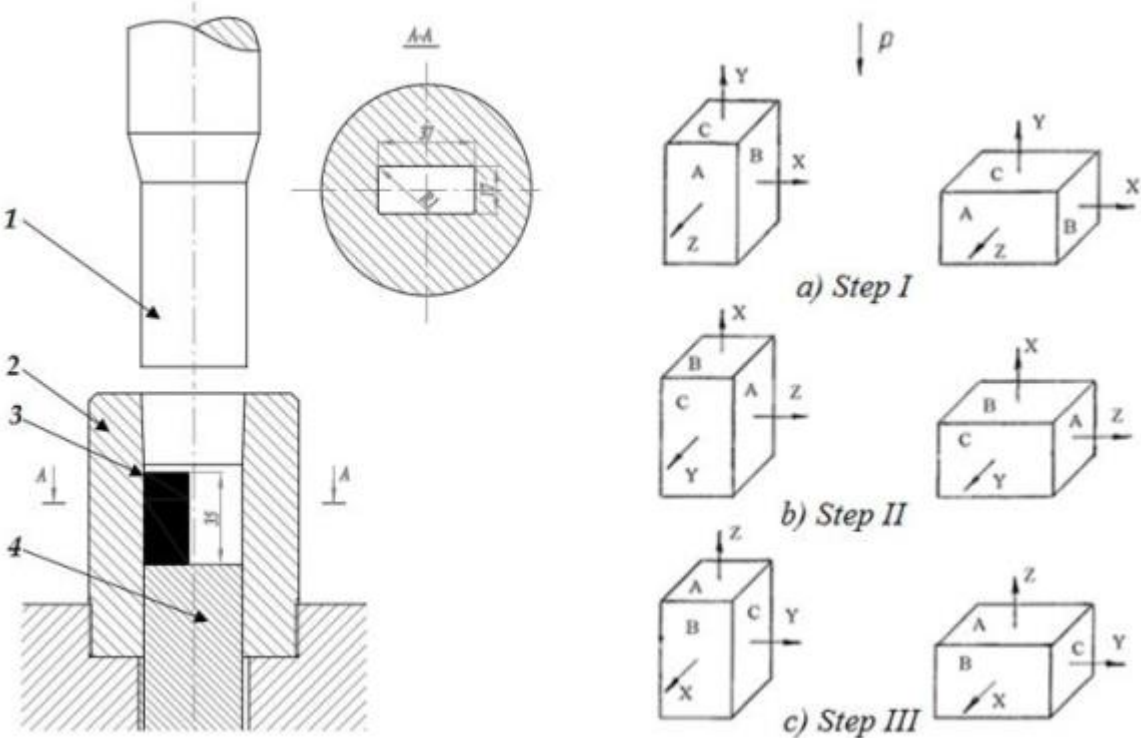
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2. Experimental procedure

The experimental method and conditions

The experimental parameters

No.	Deformation temperature (°C)	Number of deformation times (times)
1	850	3
2	850	6
3	850	9
4	900	3
5	900	6
6	900	9
7	950	3
8	950	6
9	950	9



CCDF

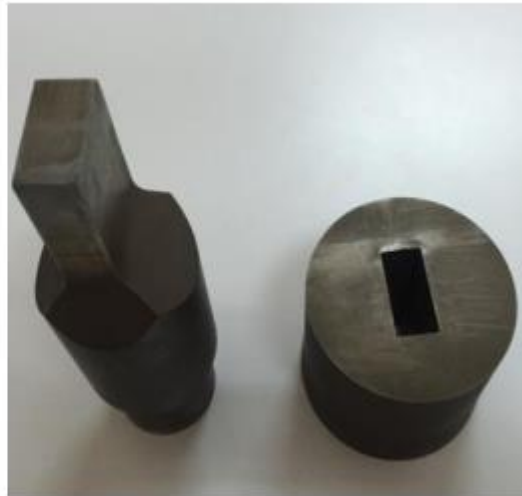
Effect of Cyclic Close Die Forging on Microstructure and Mechanical Properties of Ti – 5Al – 3Mo – 1.5V Alloy

2. Experimental procedure

The experimental equipments



The hydraulic press (YH32 – 100T)



LAB LAVM11



TT-HW2-1000



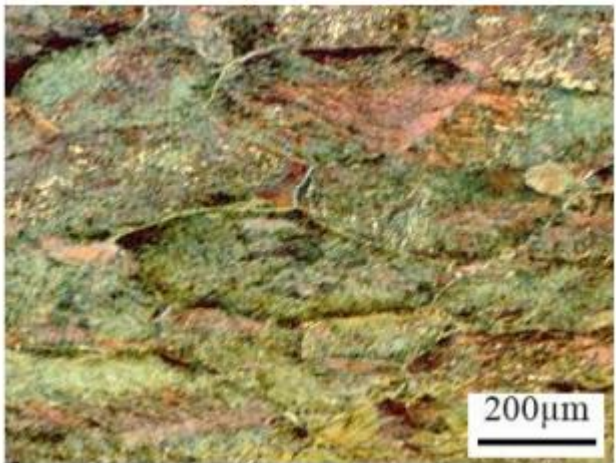
Nova-NanoSEM-450



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3. Results and Discussions



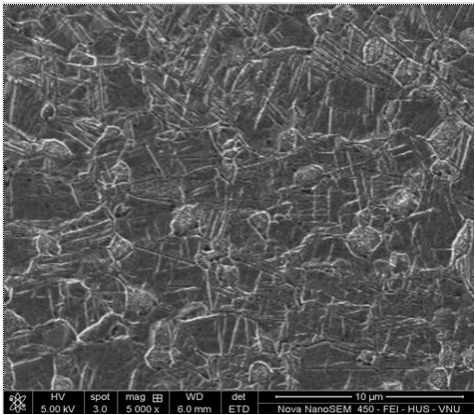
Ti - 5Al - 3Mo - 1.5V alloy
of initial test specimens
(x100)

Mechanical properties of Ti–5Al – 3Mo – 1.5V alloy

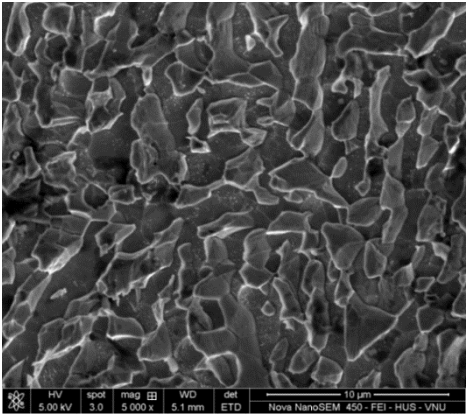
Material	Ultimate tensile stress (MPa)	Hardness (HB)	Tensile elongation (%)	Reduction of area (%)
Ti - 5Al - 3Mo - 1.5V (casting state)	980	255 ÷ 341	≥7	≥28

Effect of Cyclic Close Die Forging on Microstructure and Mechanical Properties of Ti – 5Al – 3Mo – 1.5V Alloy

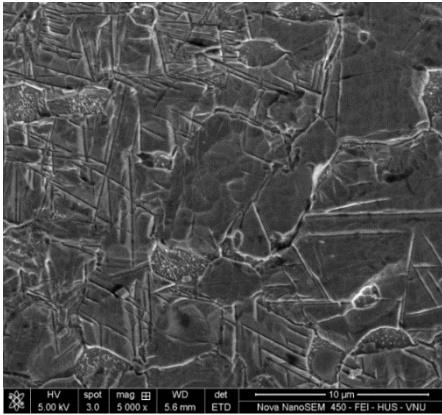
3. Results and Discussions



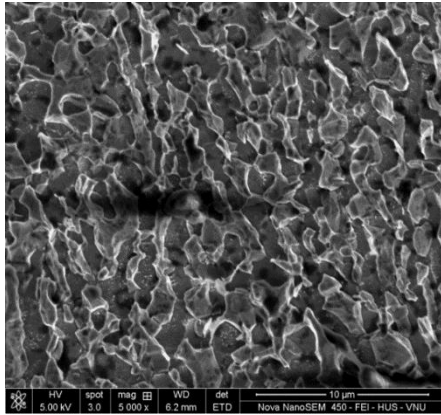
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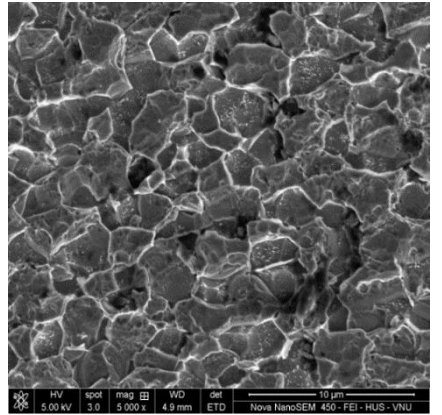
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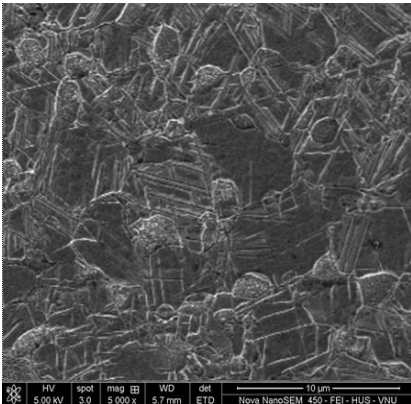
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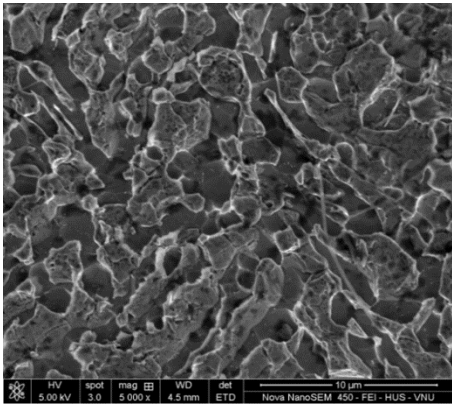
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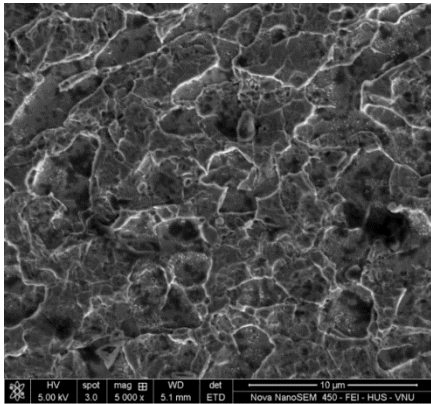
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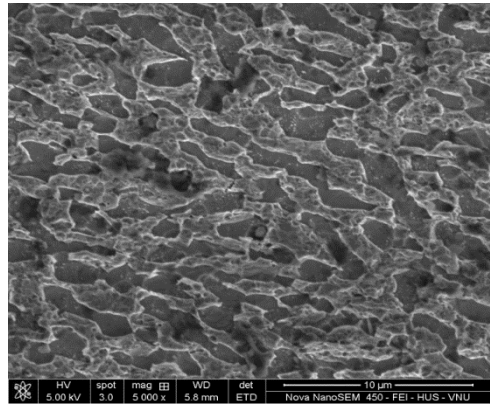
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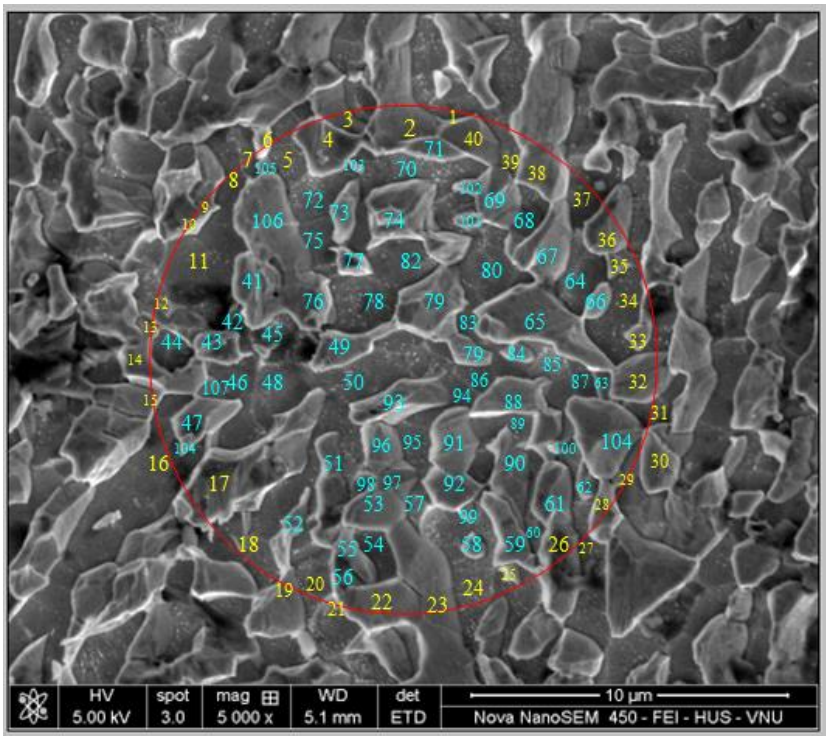
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3. Results and Discussions



The “Snyder-Graff” method

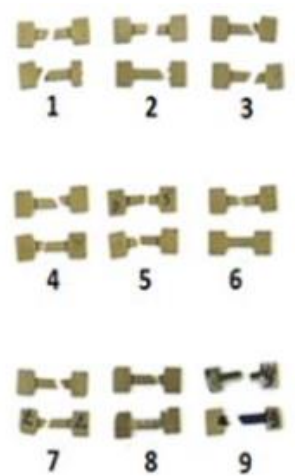
The average grain size of experimental specimens

No.	Number of grains/mm ²	Grain size index	Average grain diameter (μm)
1	382500	3	2.0
2	425000	6	1.4
3	435000	9	1.4
4	392500	3	2.0
5	455000	6	1.4
6	837500	9	1.0
7	75000	3	3.9
8	105000	6	2.8
9	125000	9	2.8

- ❑ The average grain size is decreased significantly
- ❑ It was found that at the pressing temperature of 950°C the microscopic structure of the specimens was different
- ❑ The smallest average grain size is obtained in the temperature range (870 - 900)°C.

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3. Results and Discussions



The tensile results

Mechanical properties of Ti-5Al-3Mo-1.5V alloy after CCDF

No.	1	2	3	4	5	6	7	8	9
Ultimate tensile stress (MPa)	1362	1043	1266	1085	1117	1295	1055	1196	1142

❑ The specimens after deformation by CCDF also significantly improve the mechanical properties. After 1 cycles (3 deformation times) to 3 cycles (9 deformation times) of CCDF, the ultimate tensile stress increases from (11÷43) % compared to the initial specimens

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3. Conclusions

- ❑ The CCDF of Ti - 5Al - 3Mo - 1.5V titan alloy at deformation temperature of $850 \div 950^{\circ}\text{C}$ and the number of deformation times from 3 to 9 times results in a considerable refinement of the microstructure. After one cycle of CCDF process (3 steps), the average grain size obtained approximately $3 \div 4 \mu\text{m}$ and after three cycles, the average grain size obtained about $1 \div 2 \mu\text{m}$.
- ❑ As the result of CCDF at 900°C and 9 times of deformation, the alloy exhibits a very small average grain size whilst maintaining good mechanical properties. The average grain diameter and ultimate tensile stress of the alloy was $1 \mu\text{m}$ and 1295 MPa, respectively.
- ❑ The Ti - 5Al - 3Mo - 1.5V alloy microstructure obtained after CCDF processes, which meets the superplastic forming conditions, in order to improve the plastic deformation ability of this alloy.
- ❑ The superplastic forming problems can be considered in the future work.

The image features a white background with a faint, repeating pattern of light green circles. In the top right corner, there are several green leaves with serrated edges, likely from a rose bush, extending into the frame. The text "THANK YOU FOR YOUR ATTENTION!" is centered in the middle of the image in a bold, red, sans-serif font.

**THANK YOU
FOR YOUR ATTENTION!**