ÓBUDA UNIVERSITY

DOCTORAL SCHOOL ON MATERIAL SCIENCES AND TECHNOLOGY

COMPLEX EXAM / RESEARCH REPORT

Student:
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Supervisor:
prof. Dr. Rusinko Andrew

Research title:
The Effect of Ultrasound on the Irrecoverable Deformation of Metals

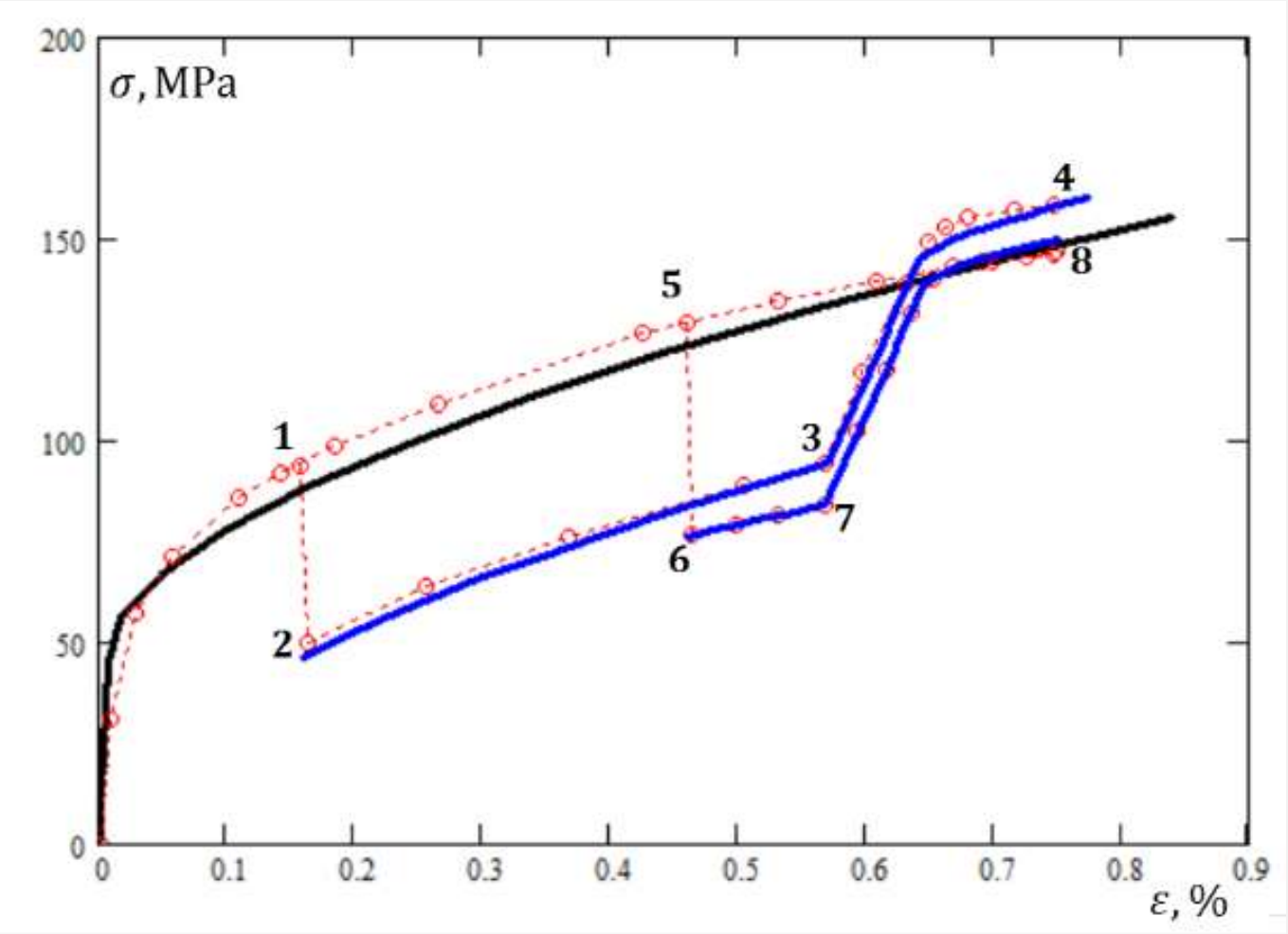
Neptun code:
F19Gox

1. THE AIM OF THE WORK

My researches are aimed to model the following phenomena:

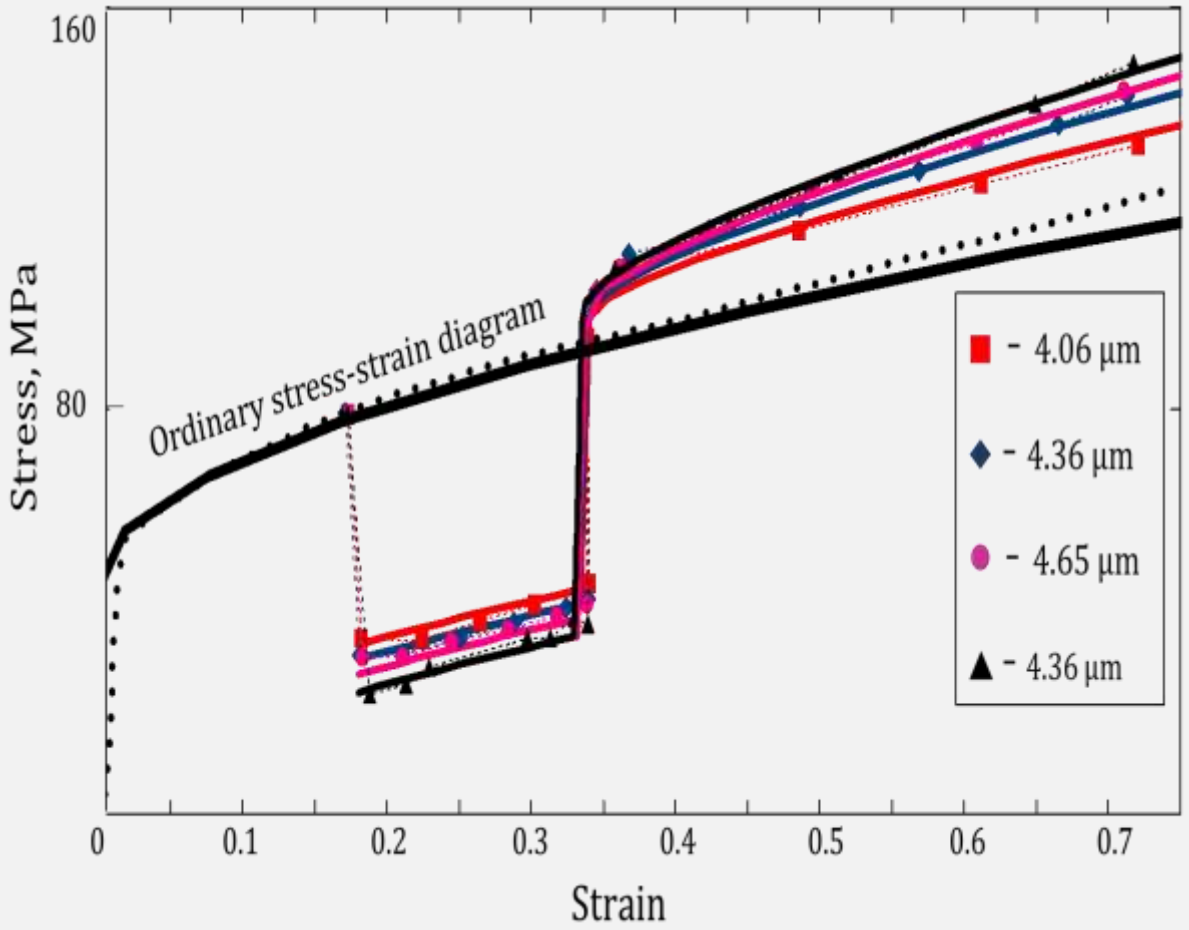
- *Temporary ultrasonic softening*
- *Residual ultrasonic effects*
- *Ultrasonic recovery of strain hardened materials*
- *Ultrasound-assisted creep for continuous and periodic sonication*
- *Ultrasonic field effect on shape memory alloys*

For mathematic apparatus I utilize the Synthetic theory of irrecoverable deformation .

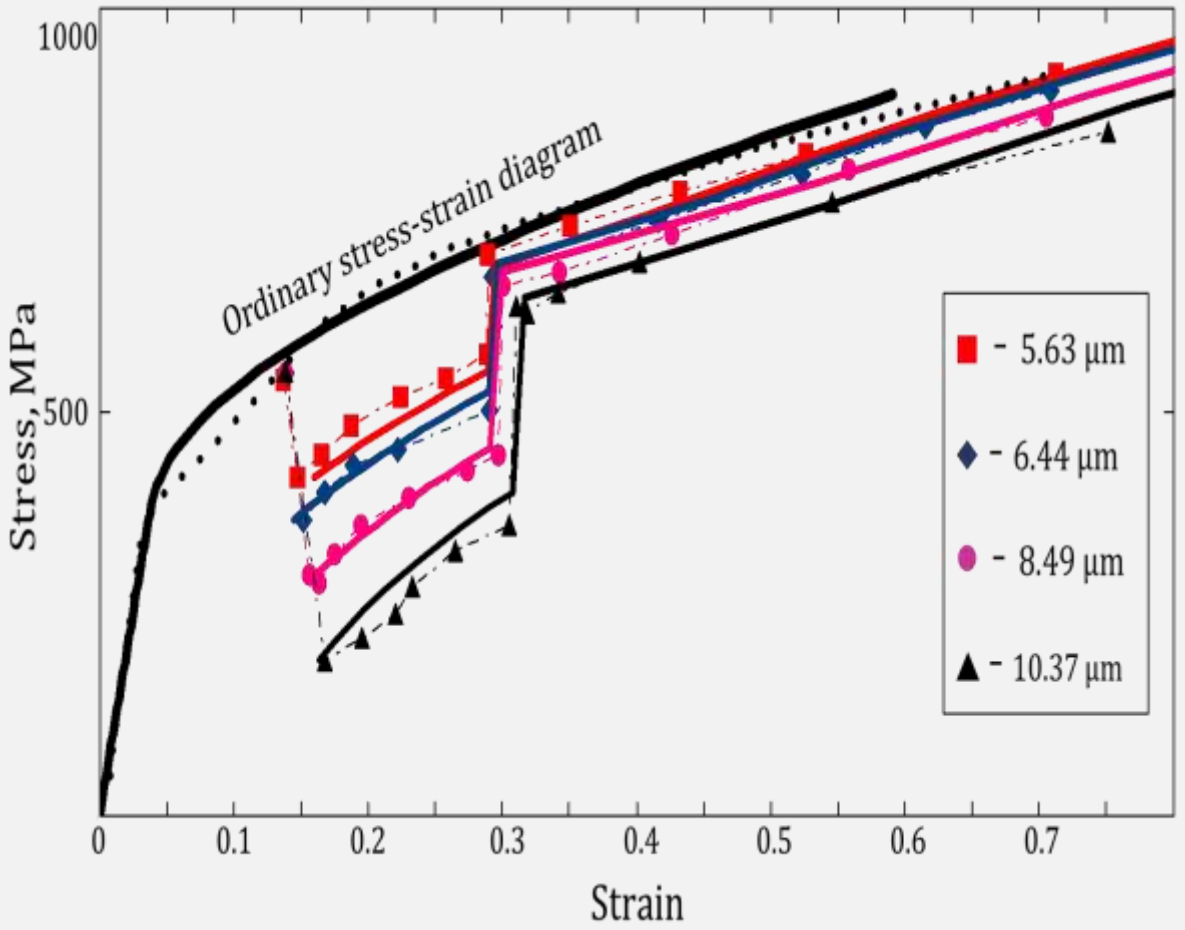


Vibration-assisted σ∼ε diagrams; lines – model, ○ – experiment.

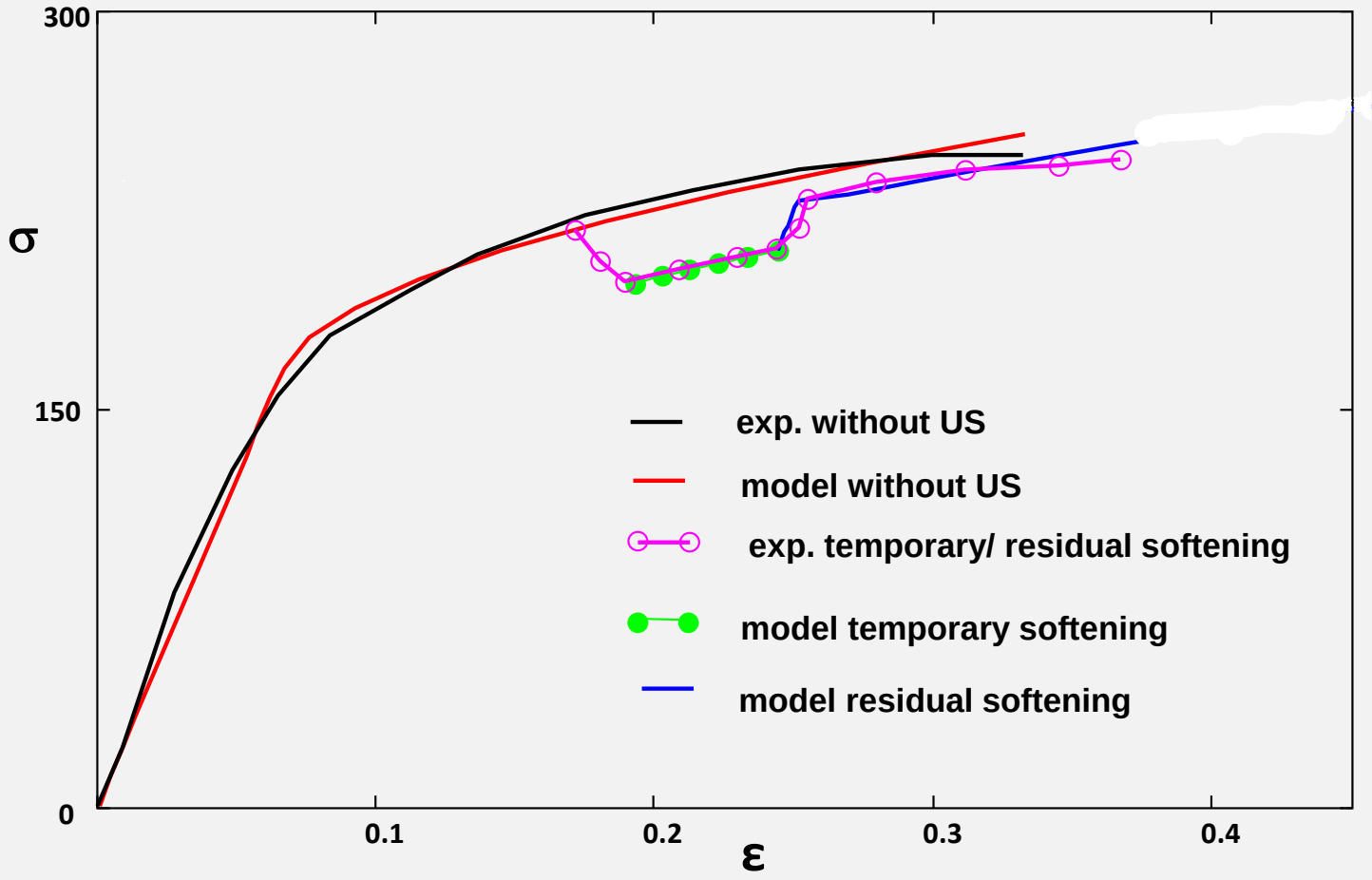
5. RESULTS



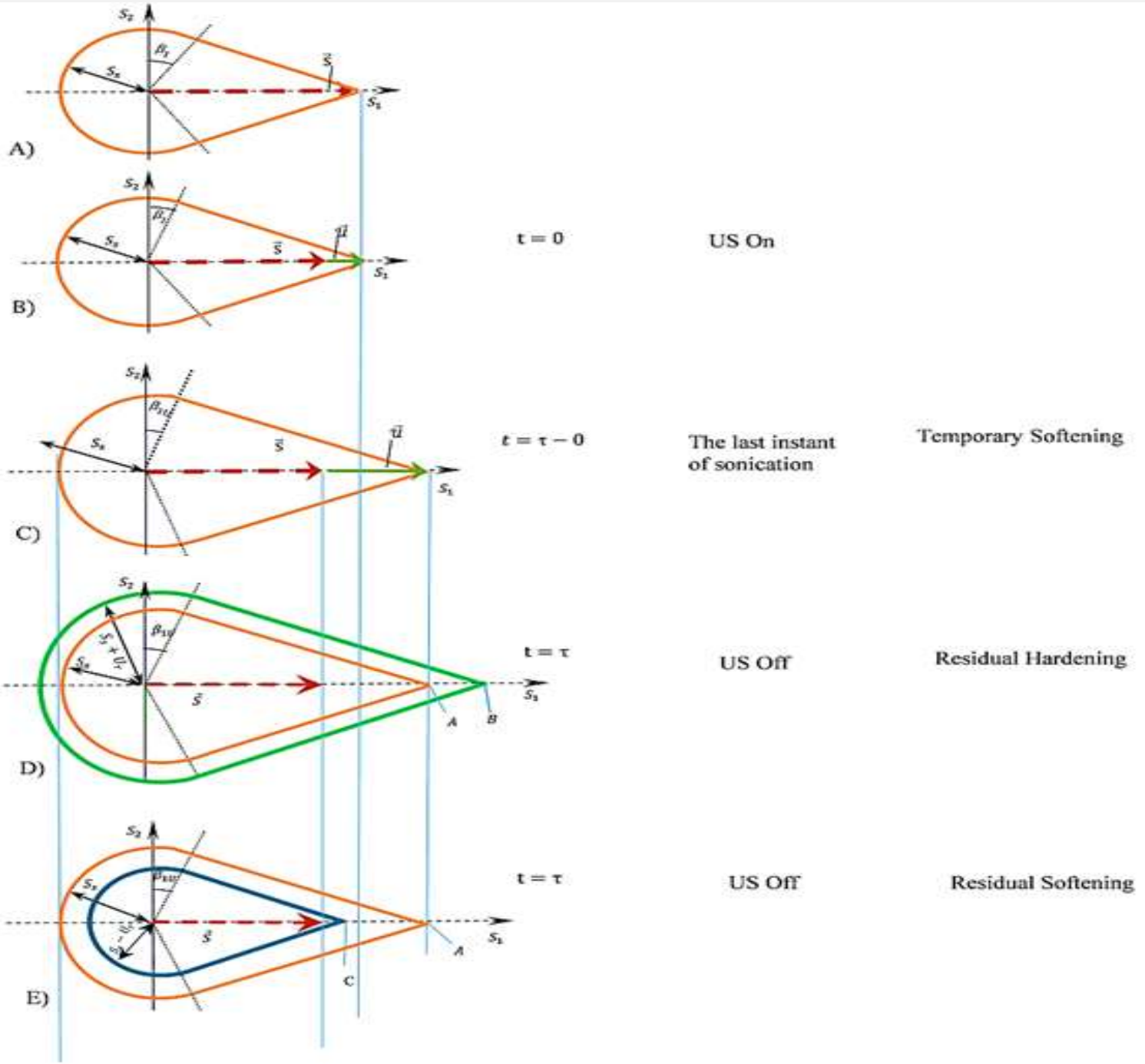
Stress~strain compression diagrams of aluminum in the ultrasonic field (symbols – experimental data; solid lines – model).



Stress~strain compression diagrams of titanium in the ultrasonic field (symbols – experimental data; solid lines – model).



Stress~strain compression diagrams (experimental data with model curves).


A)
B)
C)
D)
E)
t = 0
US On
t = τ − 0
The last instant of sonication
Temporary Softening
t = τ
US Off
Residual Hardening
t = τ
US Off
Residual Softening

Modelling of ultrasonic temporary and residual effects JTAMs, Sofia (0.4), Vol.52 (2022) pp. 64-74

Ultrasonic temporary softening and residual hardening, Nov. 2022, Engineering Review, 42(2).

Evolution of Loading Surface in the Ultrasonic Field, Proceedings of the Engineering Symposium at Bánki, vol.5, (2020) p: 35-40 ISBN 978-963-449-225-2

Ultrasonic temporary softening and residual softening, Acta Polytechnica Hungarica.

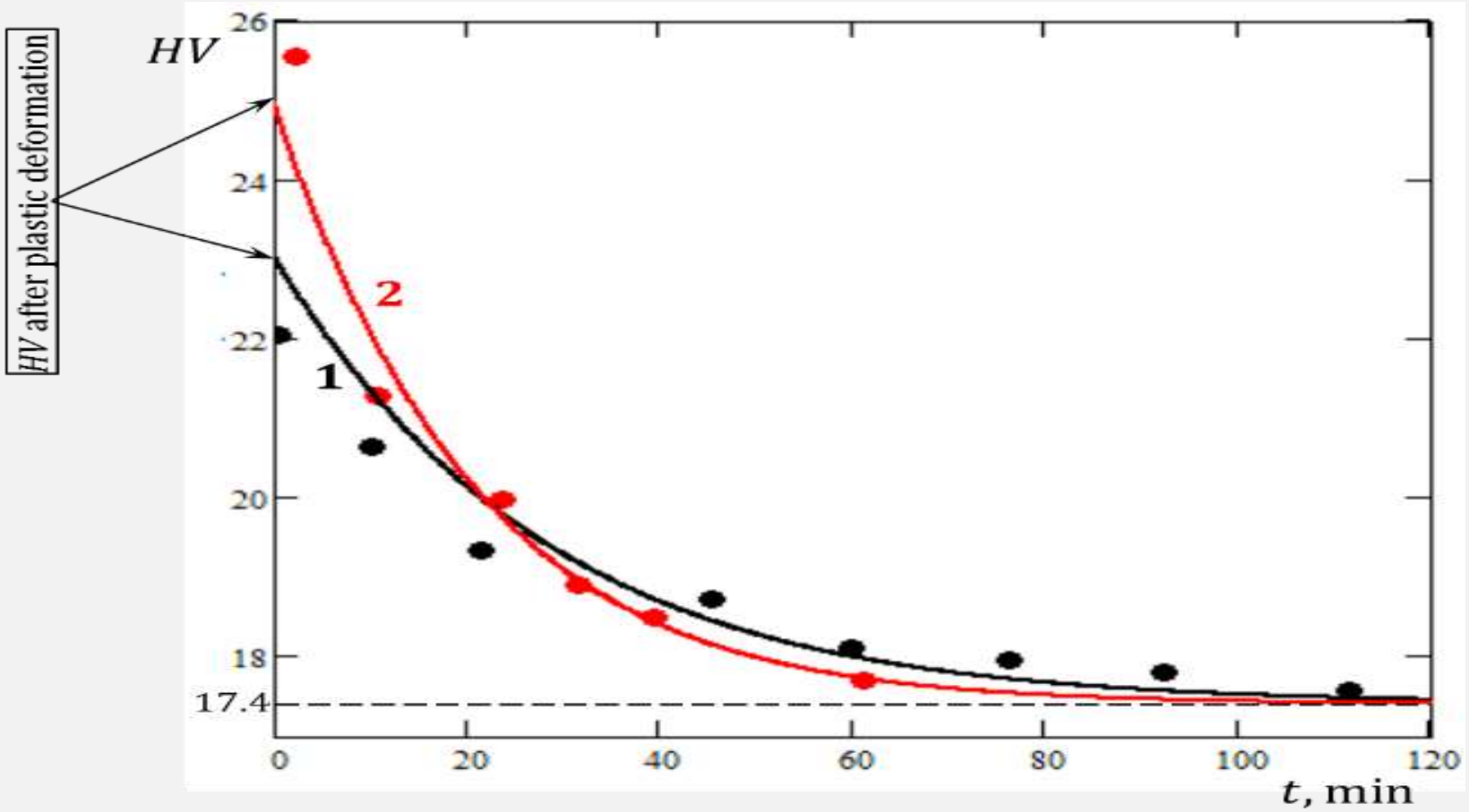
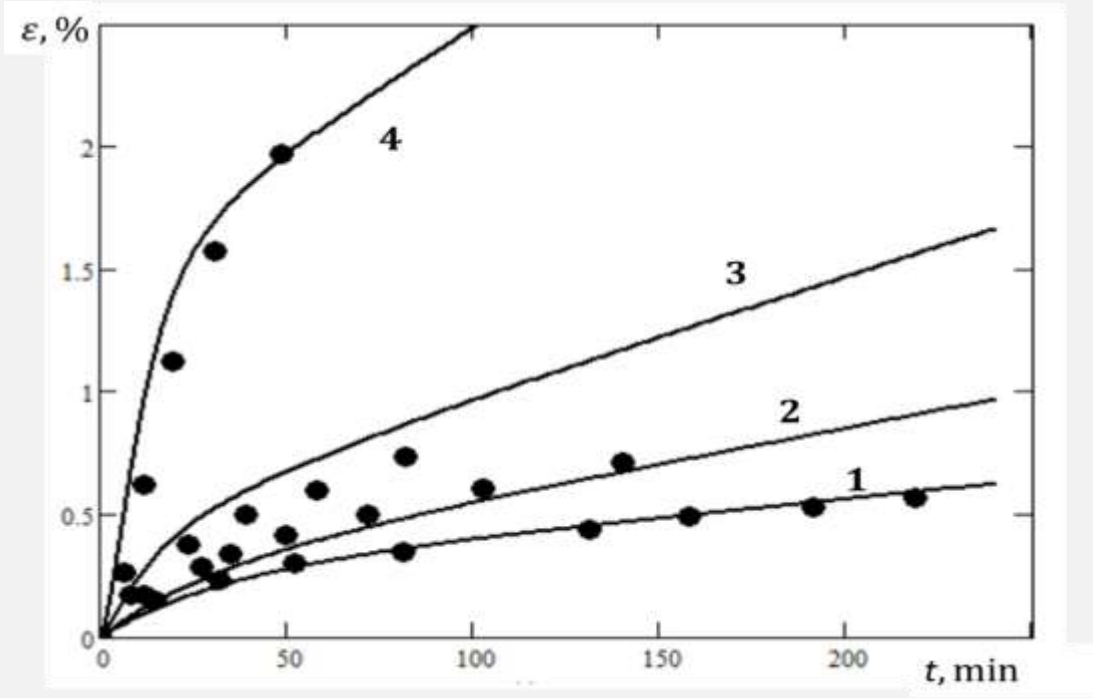
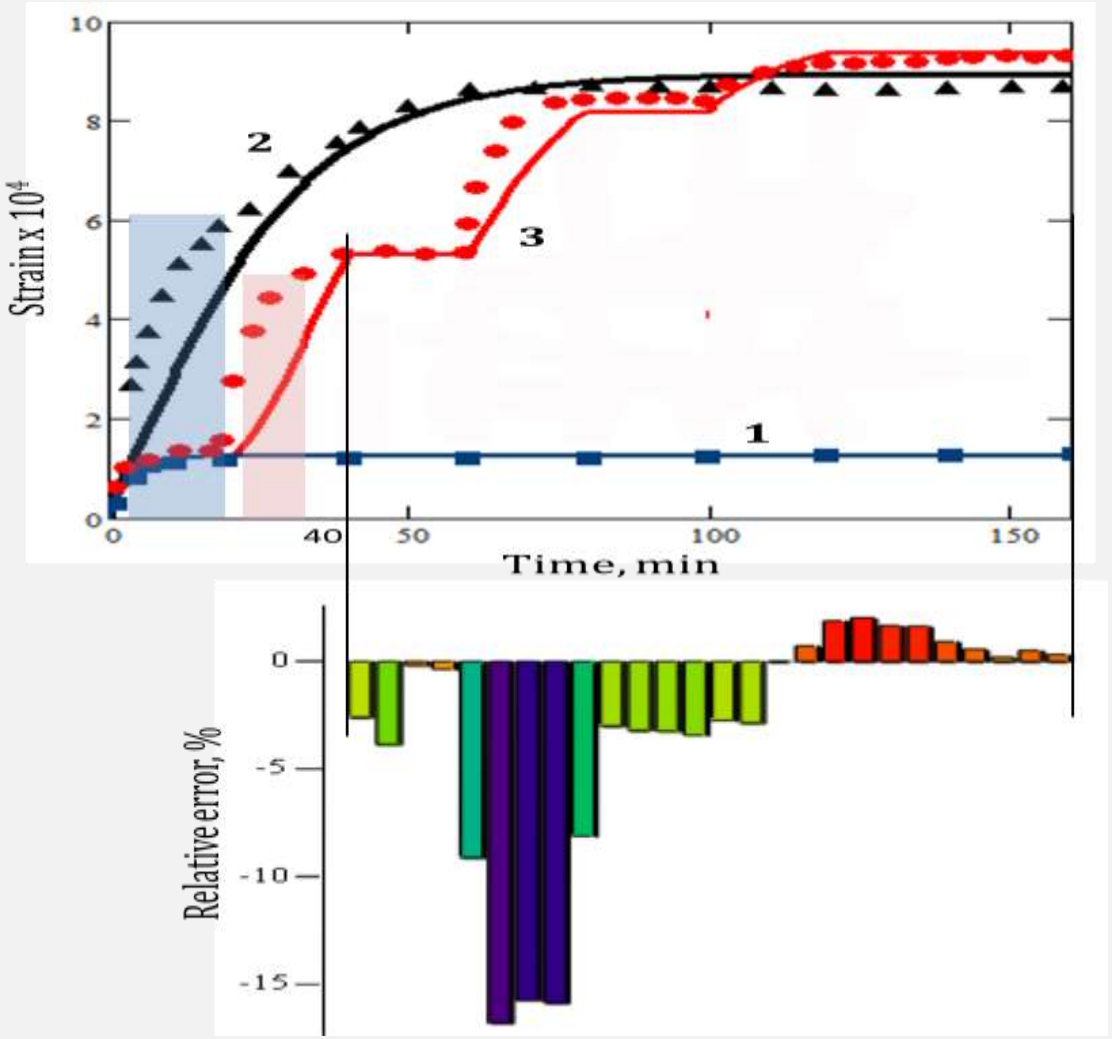


Fig. 8 HV vs. sonication time plots for the plastically deformed aluminum specimen: and. • - experiment [Kulemin, 1978], lines – model

The effect of ultrasound upon the strain hardened metals, Acta Polytechnica Hungarica (1.806), Vol. 18, No. 8, 2021-221.



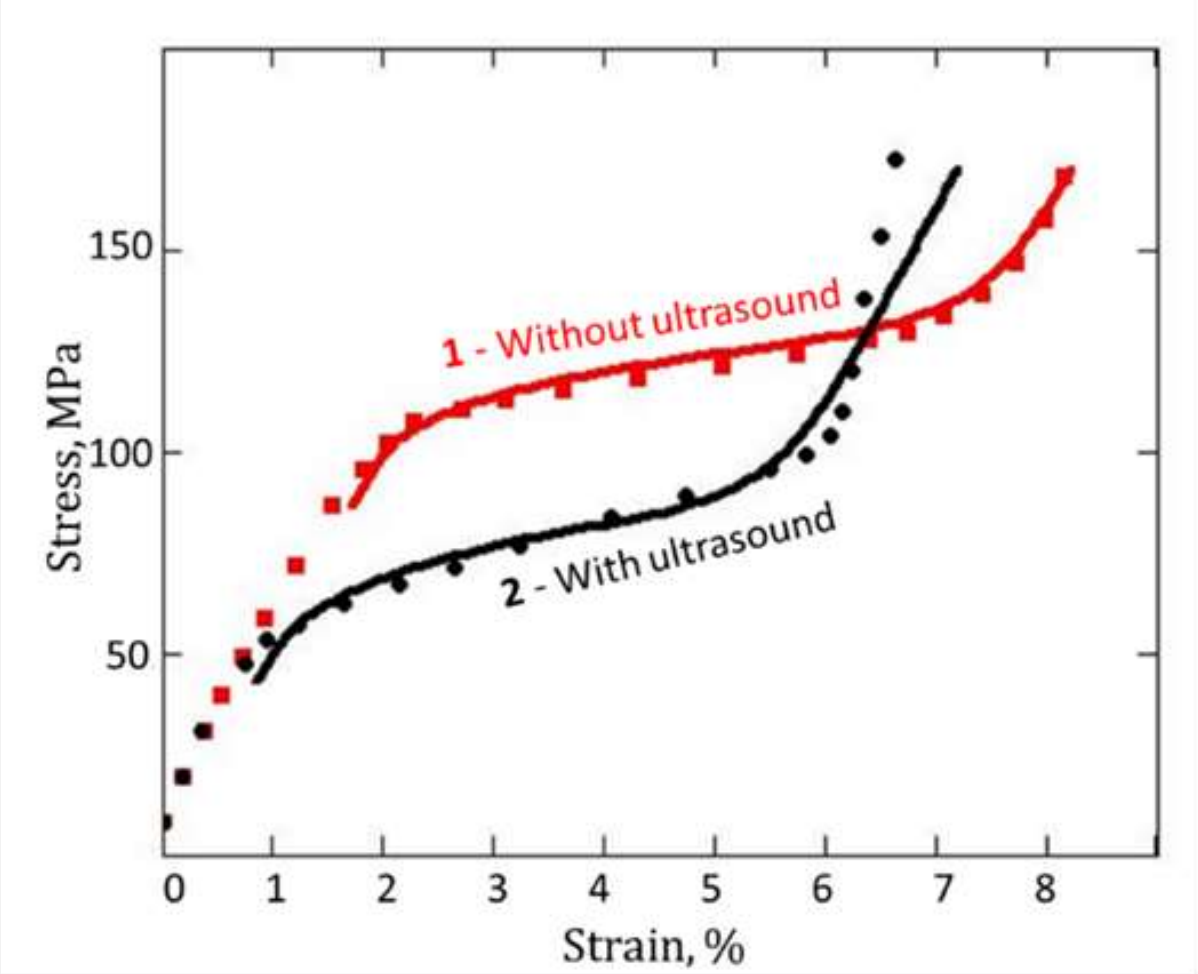
Creep diagrams of aluminum in uniaxial tension (σ=10 MPa, T=40°C), 1 – ordinary creep, 2-4 ultrasound-assisted creep with oscillating stress amplitudes of 0.6 MPa (2), 1.3 MPa (3), and 2.0 MPa (4); ● – experiment, lines – model.



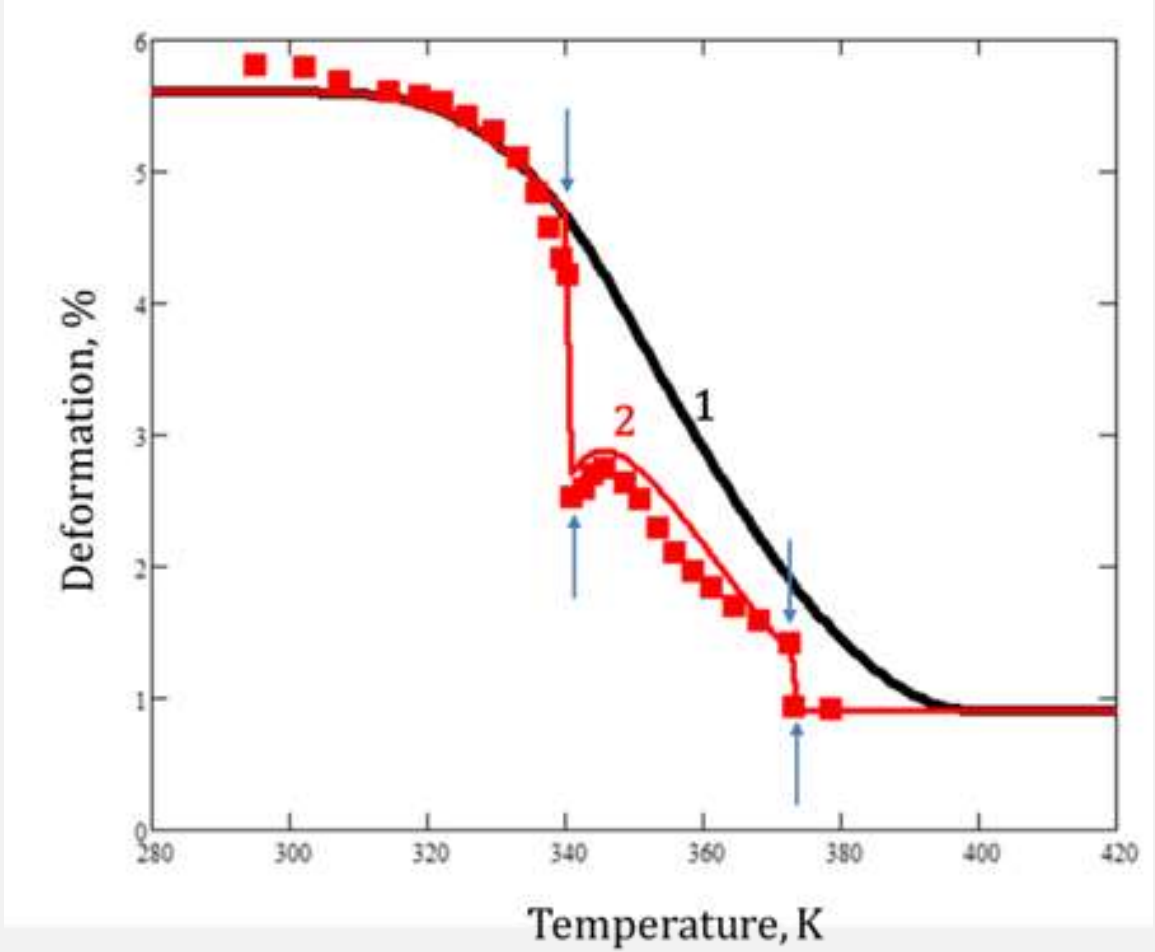
Strain vs. Time diagrams of copper: 1 – ordinary creep, 2 – ultrasound-assisted creep with continuous sonication, 3 – ultrasound-assisted creep with periodic sonication; symbols – experiment, lines – model. Error bars are constructed for the case of periodic sonication (t≥40 min).

An analytic description of the creep deformation of metals in the ultrasonic field, Mechanics of Time-Dependent Materials (1.72), vol 26, p 649–66, 2022.

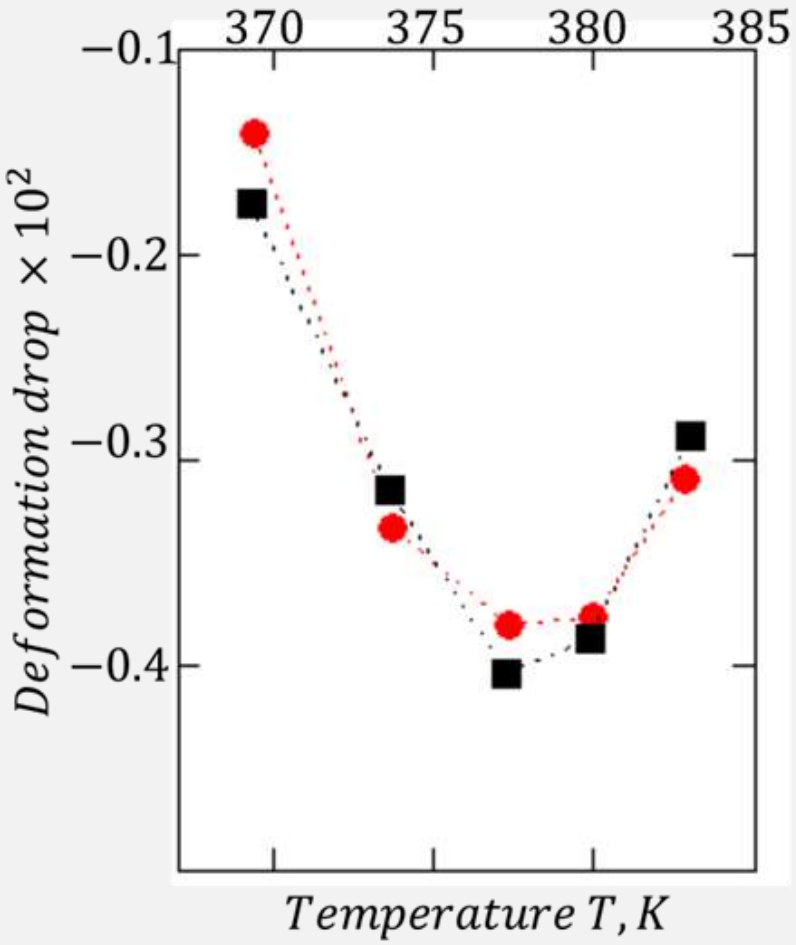
Ultrasound-assisted creep deformation of metals, Acta Periodica Technologica (1.806), 2021, Issue 52, P: 265-273.



Pseudoelastic σ~ε diagram of NiTiRe alloy at constant temperature (T_0=283 K) in uniaxial tension: 1 – static loading, 2 – simultaneous action of static and ultrasonic loading (f=18 kHz). Lines – model, symbols – experiment.



State diagram of NiTi alloy in deformation-temperature coordinate. The sample is subjected to uniaxial tension σ=30 MPa. The arrows show the moments of switching-on (↑) and switching-off (↓)of ultrasonic vibrations; ■ – experiment (Rubanik et al., 2008), lines – model.



Ultrasound-induced deformation drops in the course of austenitic reverse thermoelastic phase transformation; ● – experiment, ■ – model

Austenite transformation of shape memory alloys in ultrasonic field, Aug. 2022, Mechanics of Solids (2.5), 57.

Effect of ultrasound on the austenite transformation of shape memory alloys, Jan. 2022, MSCE (0.5) 10(06):1-12.

Effect of ultrasound on the pseudoelasticity of shape memory alloys, Journal of Theoretical and Applied Mechanics

7. LIST OF PUBLICATION

No	Published
1	Evolution of Loading Surface in the Ultrasonic Field, Proceedings of the Engineering Symposium at Bánki
2	An analytic description of the creep deformation of metals in the ultrasonic field, Mechanics of Time-Dependent Materials (1.72), vol 26, p 649–66, 2022.
3	The effect of ultrasound upon the strain hardened metals, Acta Polytechnica Hungarica (1.806), Vol. 18, No. 8, 2021-221.
4	Ultrasound-assisted creep deformation of metals, Acta Periodica Technologica (1.806), 2021, Issue 52, P: 265-273.
5	Modelling of ultrasonic temporary and residual effects JTAMs, Sofia (0.4), Vol.52 (2022) pp. 64-74
6	Ultrasonic temporary softening and residual hardening, Nov. 2022, Engineering Review, 42(2).
7	Austenite transformation of shape memory alloys in ultrasonic field, Aug. 2022, Mechanics of Solids (2.5), 57.
8	Effect of ultrasound on the austenite transformation of shape memory alloys, Jan. 2022, MSCE (0.5) 10(06):1-12.
	Accepted
9	Ultrasonic temporary softening and residual softening, Acta Polytechnica Hungarica.
10	Effect of ultrasound on the pseudoelasticity of shape memory alloys, Journal of Theoretical and Applied Mechanics

8. COURSES COMPLETED

Course	Lecturer
Finite Element Modeling Of Material Technologies	Dr. Gonda Viktor
Modeling Of Thermally Activated Transformation Processes In Alloys	Dr. Réti Tamás
Principles Of Plasticity	Dr. Endre Ruszinko
Material Testing II	Dr. Mihaly Reger Antal
Titanium And Titanium Alloys	Dr. Peter Pinke
Non-Classic Problems Of Plasticity And Creep	Dr. Endre Ruszinko
Hungarian As A Foreign Language I.	Sandor Sloboda
Finite Element Modelling Of Heat Transfer	Sándor Borza
Modelling In Crystal Plasticity	László Tóth

THANK YOU FOR YOUR ATTENTION