Dzelepov Laboratory of Nuclear Problems

Positron Annihilation Spectroscopy in materials structure studies

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Out line

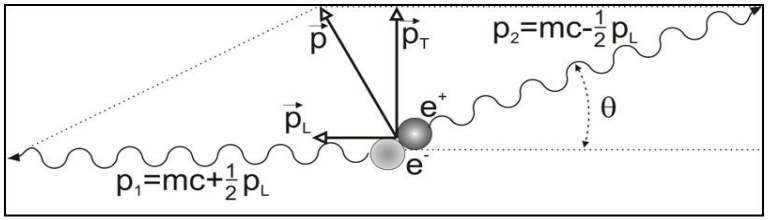
1. Principle of Positron Annihilation Spectroscopy and experimental techniques.
2. Materials and methods.
3. Results of the measurements.
4. Conclusion.

Introduction. Basics of PAS

ANNIHILATION e^+e^-

$e^+ + e^- \rightarrow 2\,\gamma$

(99.8 %, $E_\gamma \approx 511$ keV)



DIFFUSION

THERMALIZATION

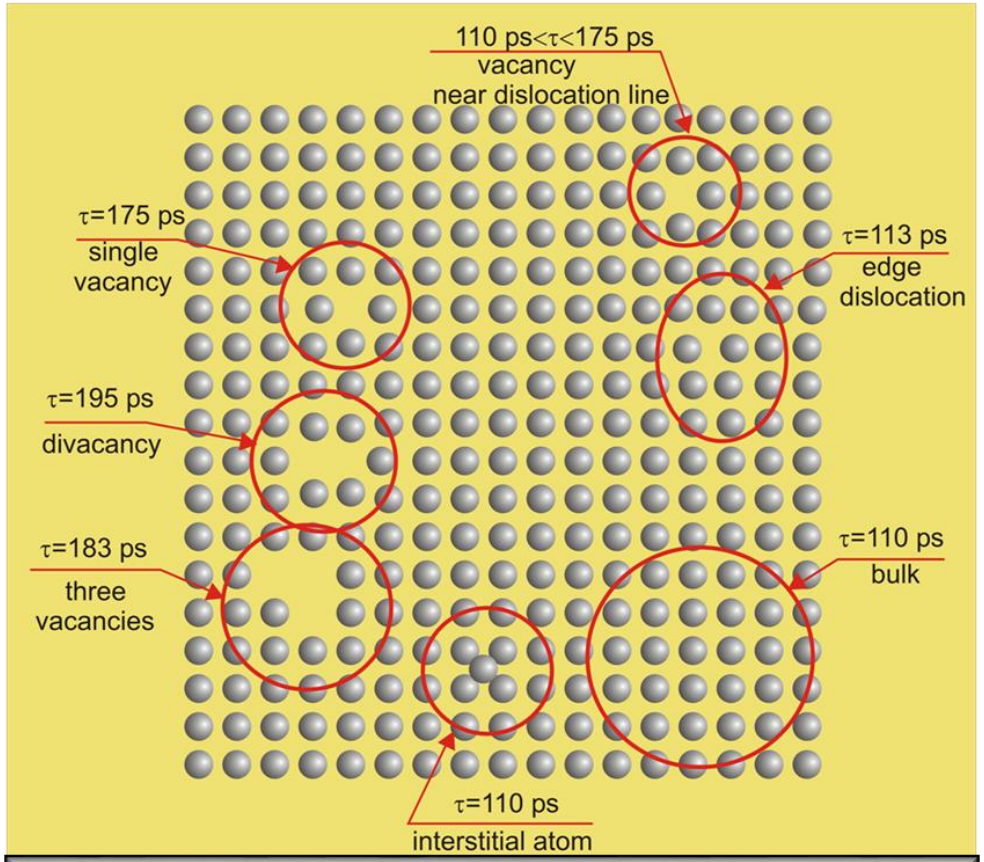
- ✓ Elastic scattering
- ✓ Nonelastic scattering
- ✓ Bremsstrahlung

IMPLANTATION

POSITRON SOURCES

$^{22}Na\text{-}\beta^+$

$$p^+ = n + e^+ + \nu_e$$



The examples of structural defects.

Introduction. Basics of PAS.

Experimental Techniques

1. *Positron life times (LT)*
2. *Doppler broadening of annihilation gamma line (DBGL)*

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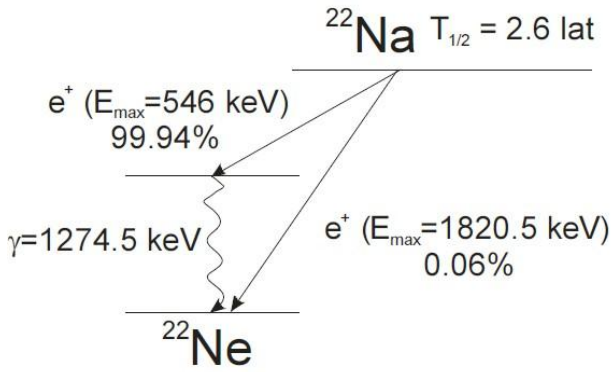

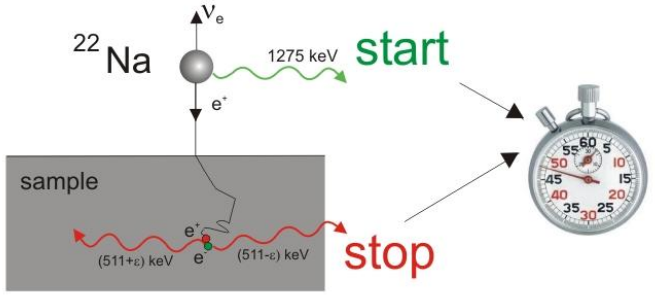

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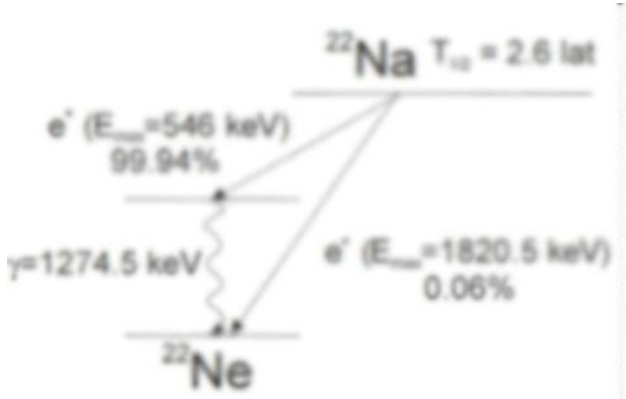

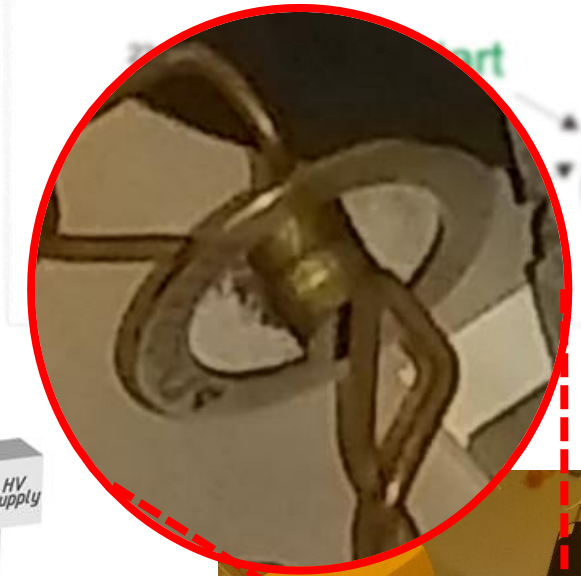

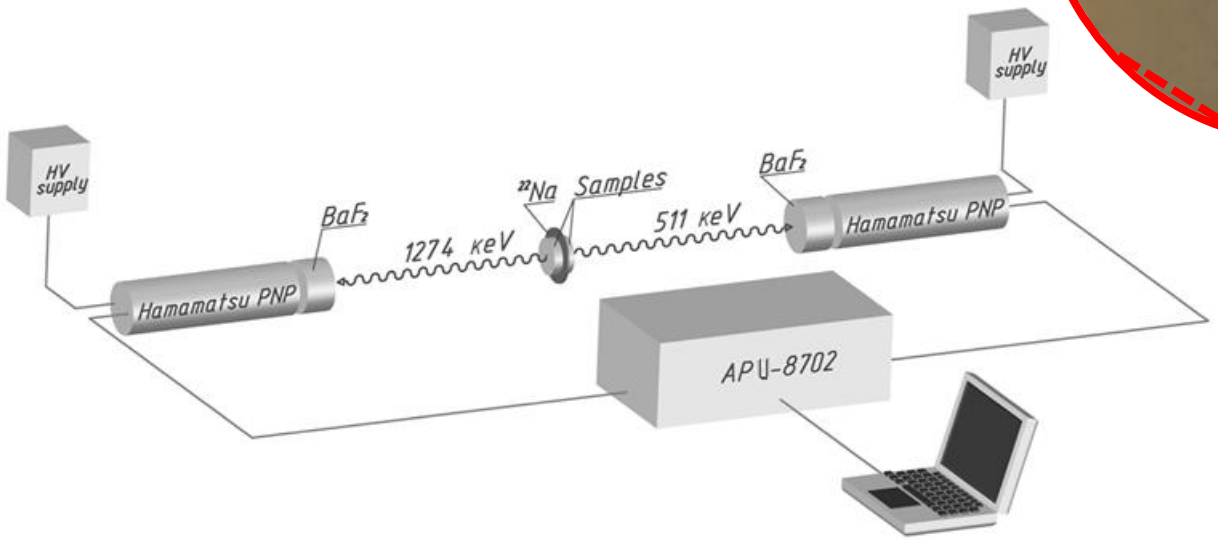

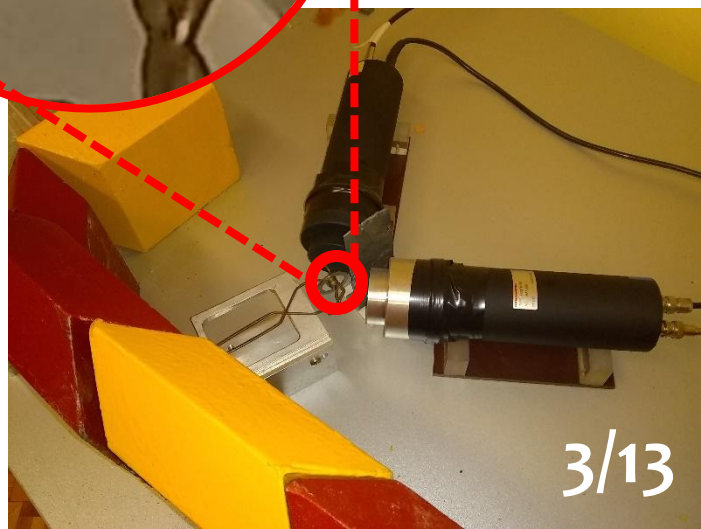

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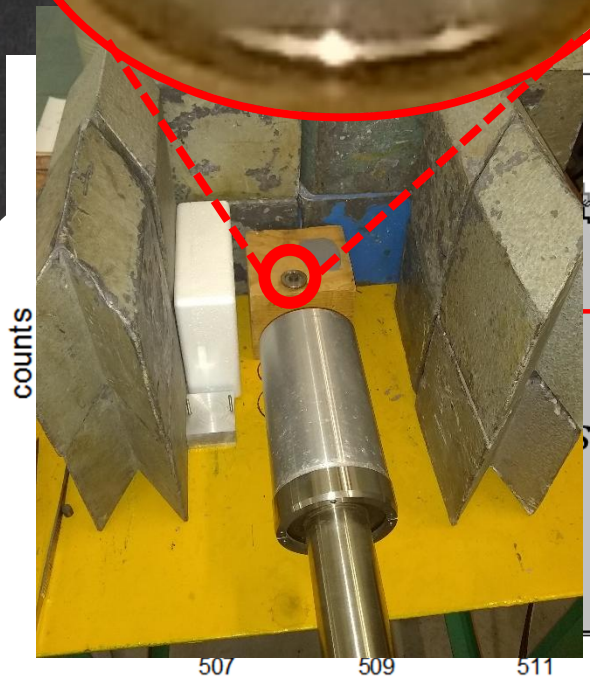

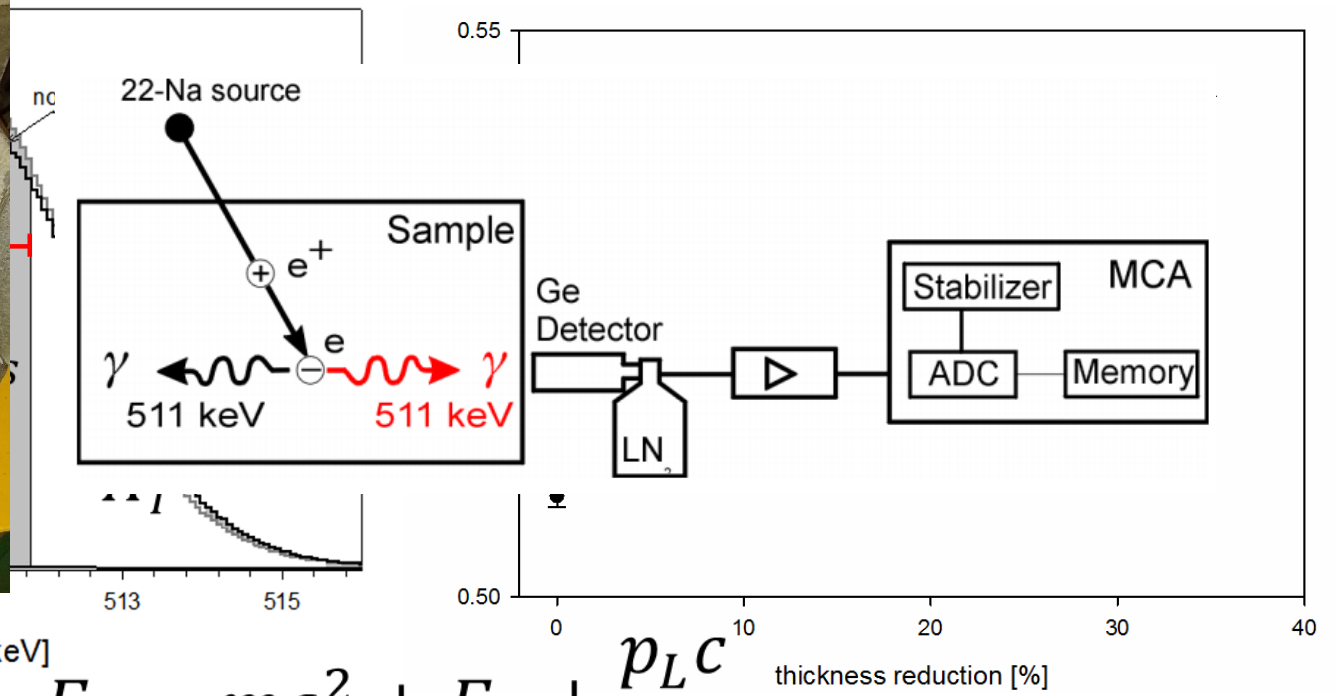

$$E_\gamma = mc^2 + E_B \pm \frac{p_L c}{2}$$

Defines the participation of pairs positron-electron with low momentum.

The bigger value the bigger concentration of such defects as vacancies.

Introduction.

More Power

KANTHAL alloy

Less maintenance

Longer Life

	Weight %						
	C	Si	Mn	Cr	Mo	Al	Fe
Kanthal APM™	≤0.05	≤0.7	≤0.4	22	–	5.8	balance

Introduction.

Scientific Problem

It is suspected that the anticorrosive properties of KANTHAL alloy will increase after sandblasting treatment

Aim

1. Estimate the damage region in the KANTHAL alloy after sandblasting.
2. Determine the temperature for which the recrystallization process takes place for the KANTHAL alloy.

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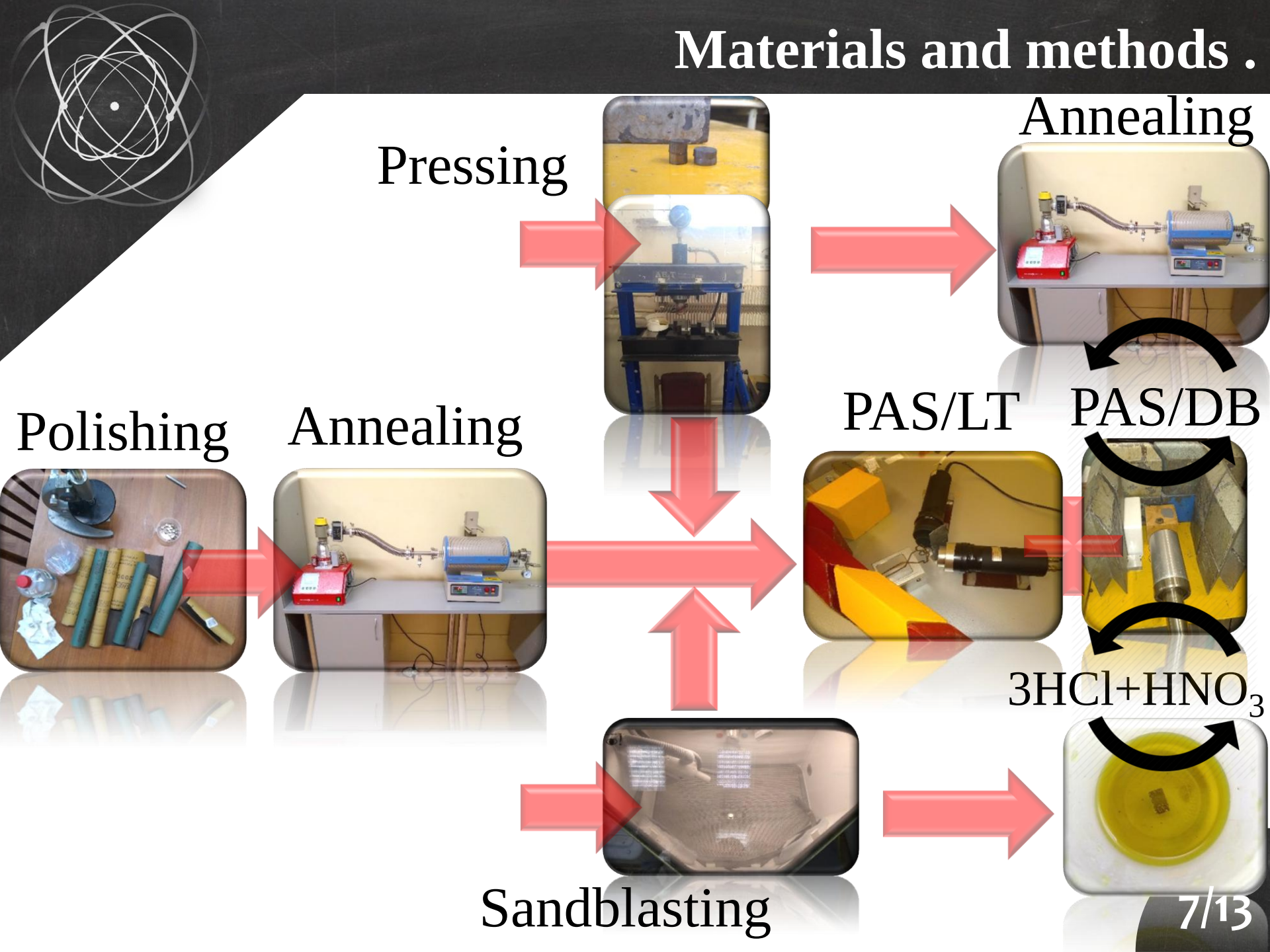
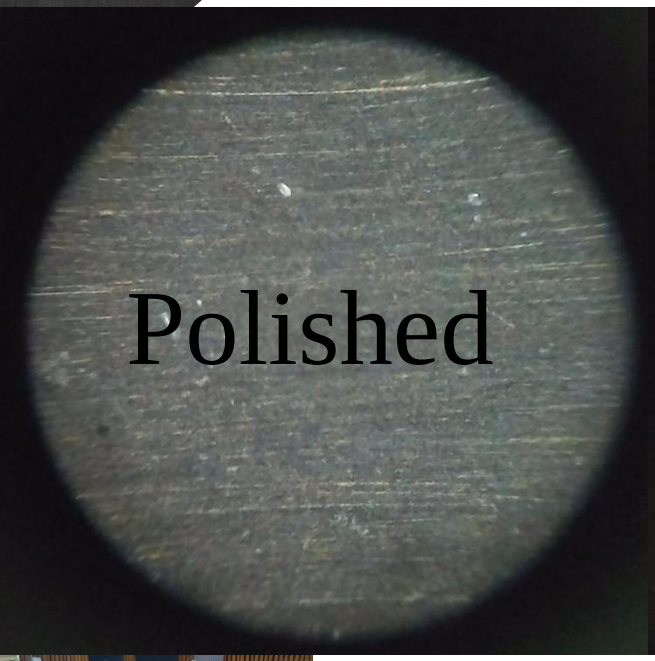
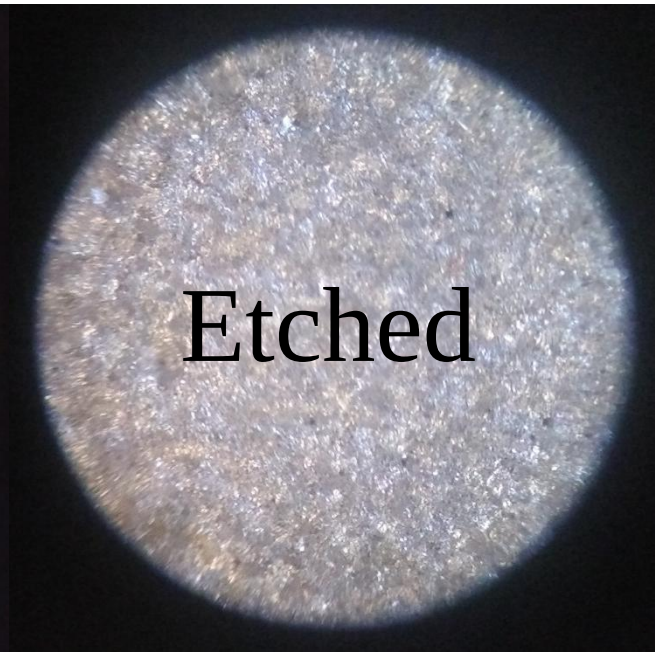
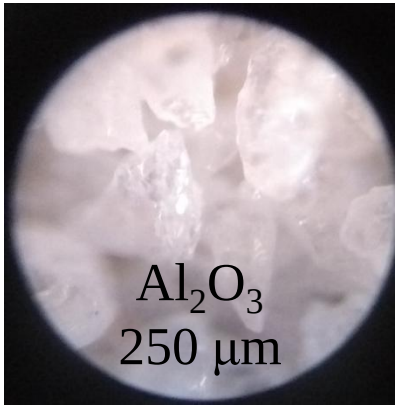
Materials and methods .



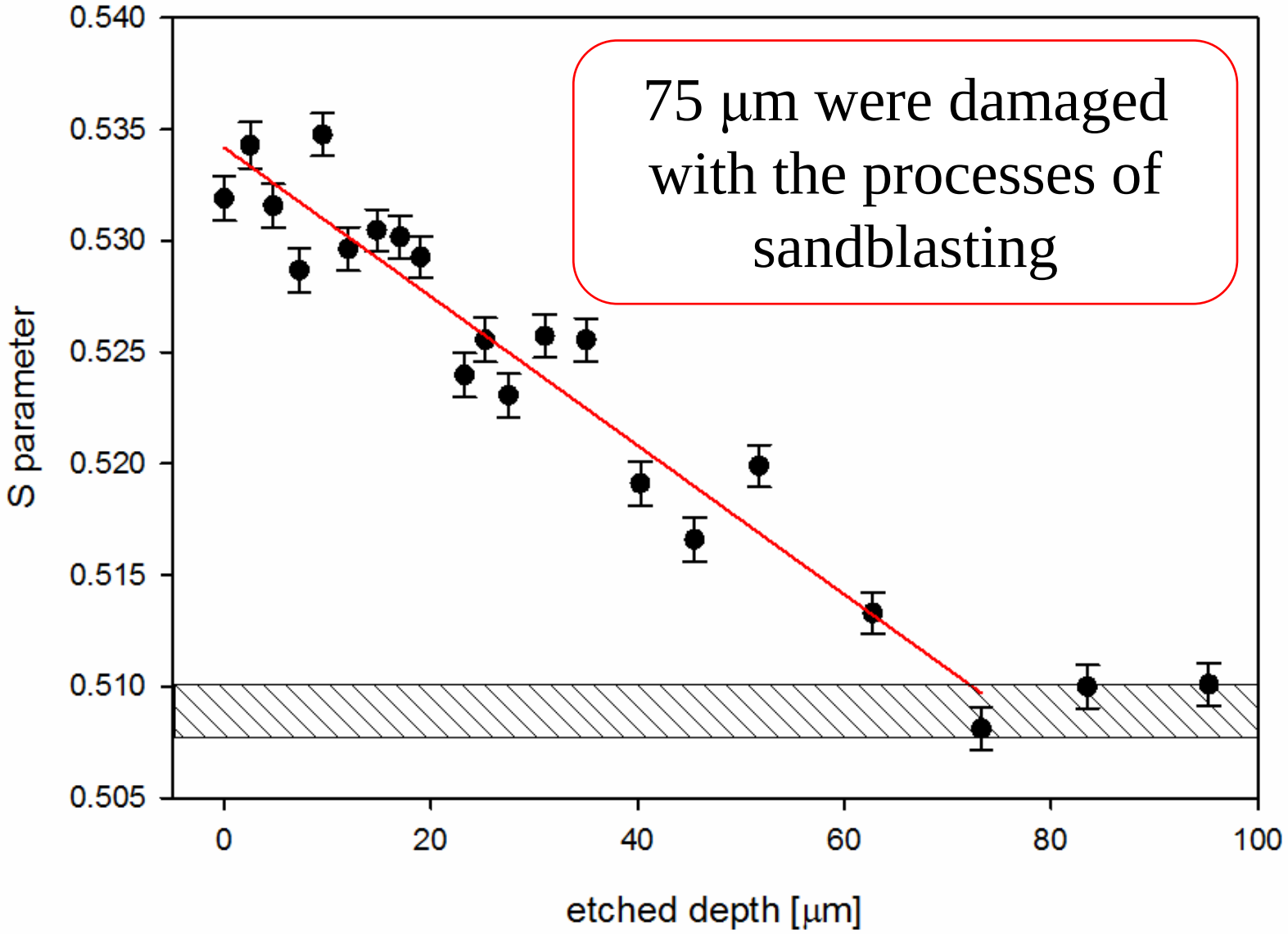
Results





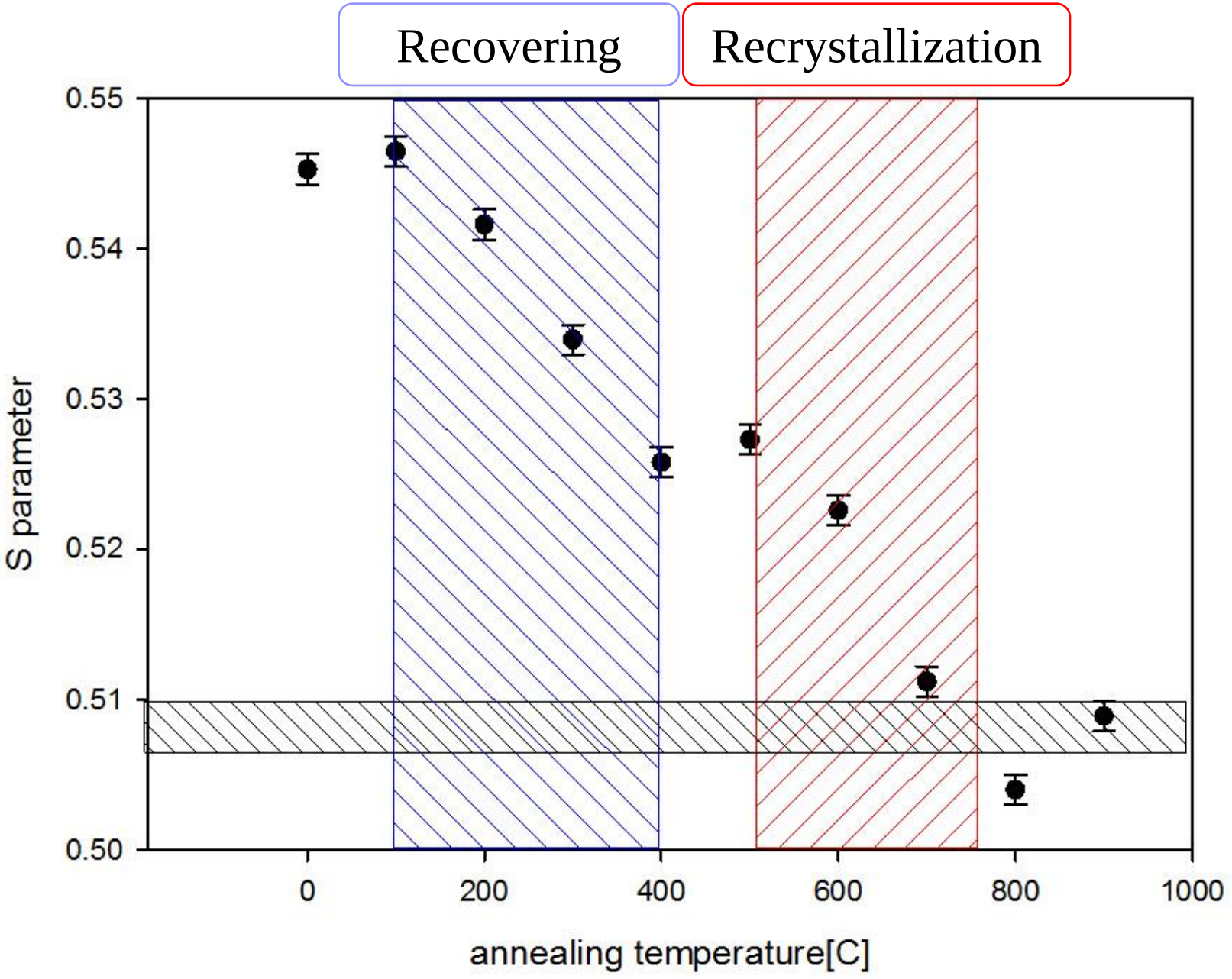


Results. Sandblasting sample



75 μm were damaged with the processes of sandblasting

Results. Annealing sample



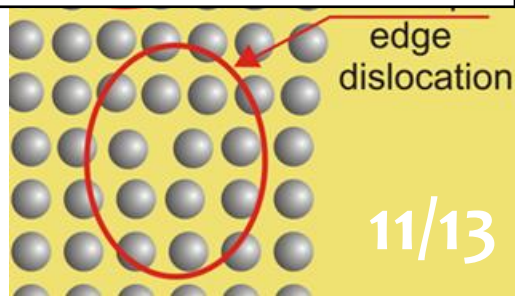
Positron Lifetime (ps)

Sample	Experimental
Annealing	113
Pressing	164
Sandblasting	158 (90,7%)
	320 (9,3%)

Results

Positron Lifetime (ps)

Sample	Experimental	Theoretical (in Fe)		
		Value	Kind of defect	Ref.
Annealing	113	110	Bulk	1
Pressing	164	165	Dislocation	2
Sandblasting	158 (90,7%)	165	Dislocation	2
	320 (9,3%)	304	6 vacancy cluster	2



1. P. Hautojarvi, L. Pollanen, A. Vehanen, J. Yli-Kauppila, *J. Nucl. Mater.* **114**, 250 (1983).
2. A. Vehanen, P. Hautojarvi, J. Johansson, J. Yli-Kauppila, P. Moser, *Phys. Rev. B* **25**, 762 (1982).

Conclusion

1. The damage region in the KANTHAL alloy after sandblasting with Al_2O_3 particle with a size of 250 μm and using a press of 4 bar is about 75μm.
2. The temperature for the recrystallization process takes place for the KANTHAL alloy begging at 500^{o}C and end at 800^{o}C.

Conclusion

When the KANTHAL alloy is etched and/or pressed, the possibility for the creation of the protective layers of Al_2O_3 on the surface is increased because new path of diffusion for the atoms of aluminum are generated, so, the anticorrosive property is increased. At temperature above of 500^oC the sample starts to eliminate all defects and the enhanced of the anticorrosive property is not remarkable.


Cuba