Engineering of experiment

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Patonin A.V., Shikhova N.M. The method of axial deformationcalculating of the specimen in testing at the inova press

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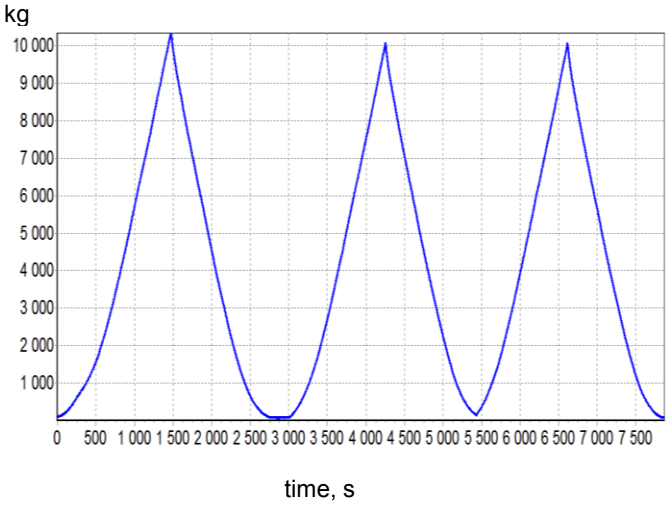
Abstract. The work describes the stages of calculating axial deformation of a rock sample when tested on the operated press INOVA in the uniaxial and triaxial deformation. During the tests most of the physical parameters is measured directly by appropriate sensors. However, due to the specific construction of the press sensor, the axial deformation of the sample is absent and this parameter is calculated from the sensor reading the position of the press plates and the level of the setting generator. The calculations are complicated by the fact that in the working area of the sensor in addition to the sample includes a number of metal structures of the press, the cell for the sample and the contact zones of these structures. To properly calculate the true axial deformation of the specimen is necessary from the position of the piston press to subtract the deformation of all structures. In addition, during the initial loading of the sample to the efforts of approximately 1000-2000 kg the sealing of contact areas, the presence of micro particles of dust, oil layer, non-parallelism of the sample, etc. in are significantly influence. In addition, the return stroke of the piston press because of design features and misalignment of the position sensor incorrect displacement of the press piston occurs. The higher the strength of the sample, the more the calculations made in error.

Keywords:rock sample, axial deformation, triaxial test.

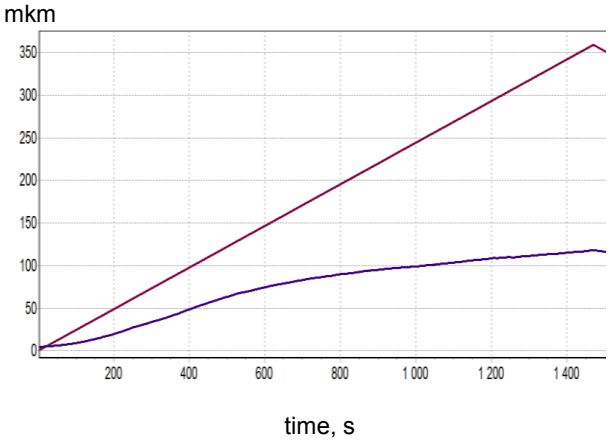
The methodology of calculation of the axial deformation is composed of several phases: 1) the determination of the elastic characteristics of the sample,2) the correction of the initial portion of the load,3) the correction of unloading zone. Readouts of the load sensor and values of the oscillator level are used as an initial data, by which the position of the press piston is controlled. According to the results of the tests on the reference materials with a known Young's modulus the deformation of all structures located in the working space of the piston position sensor is determined. The index of metal construction deformation was calculated according to the formula $K = \frac{\Delta L}{\Delta F} - \frac{\Delta L_{test}}{\Delta F_{test}}$ for elastic part of the test load curve.

This coefficient is 0.0142 m / kg for an uniaxial mode and 0.0208 micron / kg for a triaxial mode. Then deformation of contact zones which occurs at the initial stage of sample loading is defined. We proceed from the assumption that the sample behaves as an elastic body at the initial step of loading, and thus the remaining deformation falls on for deformation zones and contacts on the initial closing of the pore space of the sample.

At the working load curve (Figure 1 a)for this stage a linear part of deformation is visually selected.



a)



b)

Fig.1 Cyclical test on steel model (a) - overall view of loading curve; b) - detailed plot of the lead)

To this point the Young's modulus calculations (taking into account the deformation of press structure) is produced. The deformation of contact band on initial loading is calculated after that. This takes stock of a part of this deformation accounted for the initial stage of loading. However, starting from the point of sample unloading, due to the nature of the press (for various reasons) the law of the

chosen communication deformation of the sample and press the load designs is breaks. This leads to increasing of calculated sample deformation despite the reduction of press piston position .

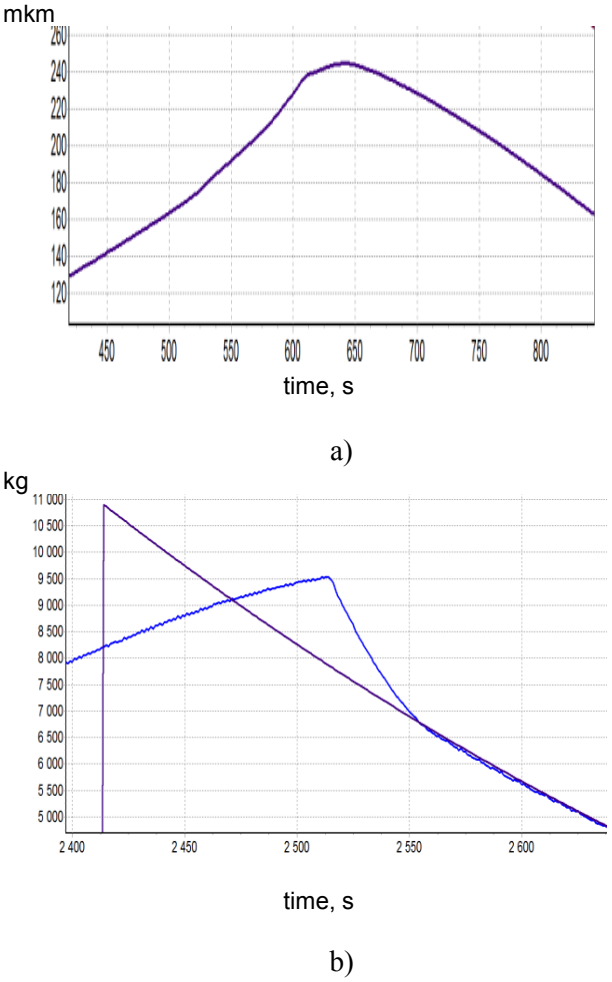


Fig. 2 Detailed plotofchanging loading sign part (a)-results of incorrect deformation analysis; b) - extrapolation of axial load at off-loading stag)

The correction of this distortion is based on the assumption that the sample deformation should decrease monotonically smoothly (without substantially changing the drop function for reducing the linearity range of the piston position) during the unloading. Therefore, at this stage of uniaxial deformation correction the area on the load curve, from which the behavior of the press can be considered stable is visually defined (Fig. 2 b) and the behavior of loading is reconstructed by polynomial extrapolation. Approximate estimation of error in the calculation of the true sample axial strain is equal to 15-20% .Results are (Fig. 3a) plotted in the coordinates of stress / strain (Fig. 3b).

The graph shows that the recovery of the axial deformation on the descending branch was carried out appropriately and describes real physical process. However, incorrect behavior of the press is appeared in the initial stages of the subsequent stages of load cycles up to about 20-23 MPa once again. It is closely relatedwith the moment of loading plate change, but in the opposite direction. The initial portion of the load curve to values of 20-23 MPa should be fully repeated an unloading area in this range. However, super imposed on this deformation effects contact zones that are difficult to take into account. For a reliable calculation of the mechanical characteristics of the sample we recommend to use portions of the curve located above the level of 25-30 MPa of an axial load.

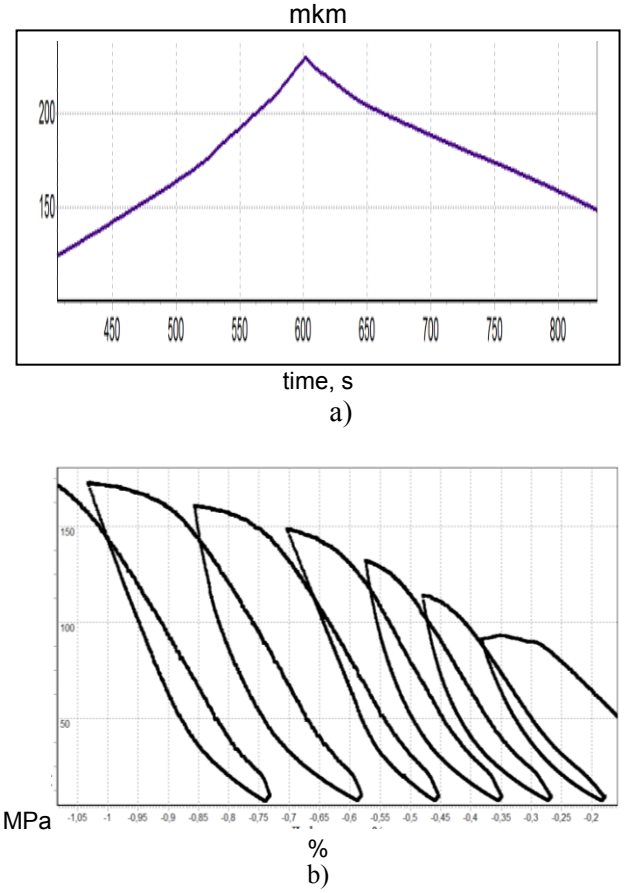


Fig. 3 Real axial deformation (a) -results of correct deformation analysis.b)- graph deformation/pressure)

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Yakov I. Korepanov, Nikolai N. Zhdanov, Evgenii G. Osadchii. Method and techniques of determination activity of silver in Ag-Au alloys

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Keywords: galvanic cell, electrochemistry, thermodynamics of alloys, silver, gold.

Introduction An electrochemical cell has been developed for determining the activity of silver in alloy depending on its concentration in temperature range 253.15 K - 423.15 K and atmospheric pressure.

A salt solution of glycerin is used as an electrolyte. Measurements can be simultaneously performed on 12 different samples in the cell under identical conditions for all compositions of the solid solution studied. This is ensured by using titan electrode being displaced from sample to sample. In this case, the comparison electrode is common and immobile, thus substantially increasing the accuracy and reliability of experimental results, since this allows one to perform repeated measurements of the EMF at a constant temperature on any sample. We discuss obtained results activity of Ag and thermodynamic properties of Ag-Au alloy in temperature range 253.15 K - 423.15 K.

Experimental and analytical techniques

Liquid glycerine based electrolytes are used to determine the thermodynamic properties of crystalline substances by a galvanic cell (method of electromotive force or EMF method) [Voronin 2011]. Glycerin brand image "dynamite" dissolve salts of various metals (AgCl, CuCl, $NiCl_2$, etc.) it can be used as a universal electrolyte with cationic ion conductivity for many metals [Babanly, 1992]. To increase the ionic strength by using a saturated KCl solution with a small amount of chloride element investigated during the experiment.

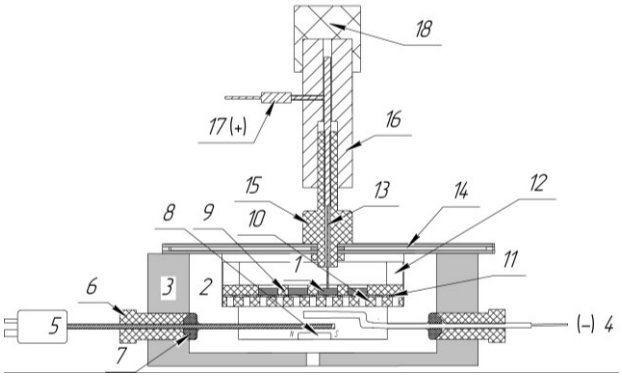

Fig. 1. Scheme of the electrochemical cell [E. G. Osadchii 2016] .. 1 - sample 2 - Tub of PTFE, 3 - the thermal clip from brass, 4 - silver electrode 5 - thermocouple, 6 - screw fixing 7 - seal 8 - magnetic anchor 9 - Separator for samples 10 - PTFE platform with holes, 11 - a gauze pad, 12 - the compression ring, 13 - titanium electrode, 14 - thermal insulation cover 15 - guard for vertical fixation of the titanium electrode, 16 - brass cylinder for mounting and vertical movement of the inert electrode 17 - screw to secure the inert electrode (contact), 18 - insulator (pen)

The electrochemical cell (Fig. 1) is designed to determine the activity of a solid solution component (alloy) sequentially in 12 samples (1) at a temperature up to 130 ° C and atmospheric pressure. Ability to work measurements substantially simultaneously with a relatively small time measurement for the same sample under identical conditions and is one of the main advantages of the cell.

Samples were placed on a removable disk (9) is cut out from PTFE plate thickness. Samples used for fixing the separator (10) of the same PTFE sheet. Between the disc and the separator is laid some gauze layers (11), which prevents splashing of electrolyte when stirring anchor magnetic stirrer. Assembly for fixing the samples (9, 10, 11) is pressed tight fitting PTFE ring (12) to avoid the separator flooding and provide a clear regulation of the glycerol level. This measure is necessary to avoid contact of the triple sample inert electrode and glycerol, which can significantly distort the results obtained from the formation of an open circuit correctly.

Inert movable electrode (13) is located in the center of thermal insulating cover (14). For the moving and fixing of the electrode in the selected sample in the hole conductor (15) mounted on the lid. As the conductor loosely fits brass cylinder (16) which is fixed coaxially to the inert electrode. The position of the electrode is fixed with the screw (17), which is also the electrical contact (anode) of the electrochemical cell. an insulator (18) is mounted on a brass cylinder, which prevents contact with the manipulator arm while moving the electrode.

Measurements of EMF and temperature were carried out using a universal voltmeter brand GDM-78 261 with 6-channel attachment, high impedance input unit (10^9 - 10^{11} ohms) on the basis of INA116PA homemade chips and its own computer program adapted for this kind of measurement. The result of successive measurements of EMF and temperature pre-set intervals (minimum 0.2 seconds) are recorded in a file and simultaneously displayed in graphs. At the end of the measurement on the graph are allocated for each selected composition ranges of values of EMF and temperature, and their average values are written to automatically generate a spreadsheet file.

Results. The points of this table is shown in Fig.2.

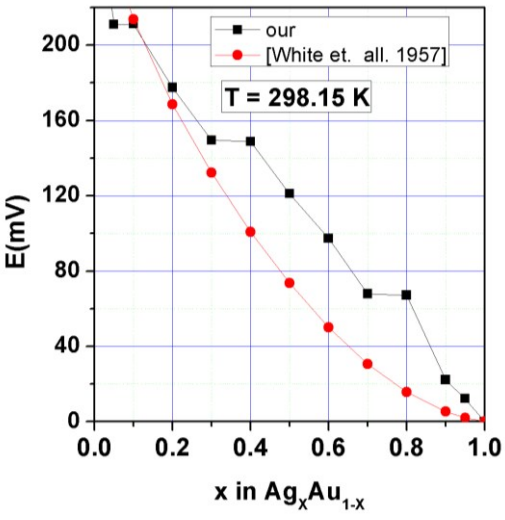

Fig. 2. EMF (E) of the electrochemical cell
(-) Ag | KCl (saturated), AgCl, glycerol | AgXAu1-X | Ti (+) at a temperature of 298.15 K and Subregular model [White et. all. 1957].

Taking as a standard condition of pure silver, and using basic equations of thermodynamics:

$\mu_{Ag} - \mu_{Agss} = G(Ag) = -nFE \cdot 10^{-3} = RT\ln(a_{Agss})$, where n = 1 - number of electrons in the electrode process Ag + + e = Ag; F - Faraday constant; E - emf of the cell in mV, to determine the activity of silver in the alloy of a given composition.

Using the equation of Gibbs-Duhem calculated activity in the alloy of gold (Fig. 3) and further mixing G^M thermodynamic function, S^M, H^M [4].

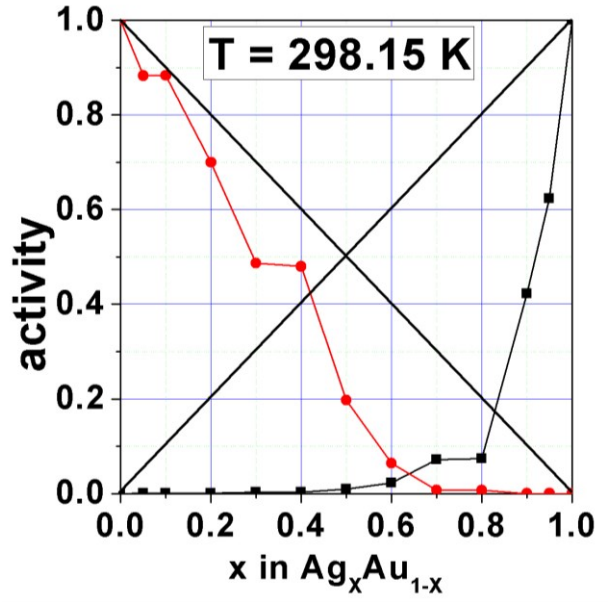

Fig. 3. Activity of Ag and Au in the Au alloy, Ag_XAu_{1-x} at a temperature of 298.15 K.

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