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STABILITY OF PRIMARY STANDARD THERMOMETER

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Abstract: Developed new technology of heat procedure for preparation pure structure of platinum wire, which produce stable resistance coefficient, stable crystalline structure sturdy against contamination of inpurities. By this technology we produce Primary Standard Platinum Resistance thermometer what present high sable resistance thermometer with stability level ±2 to $3x10^{-4}$K what is stability level of water triple point cells 273.16±2 to $3x10^{-4}$K, testing device in laboratory.

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Keywords: sensor, crystal structure, dislocation.

1 INTRODUCTION

The platinum resistance thermometer /PRT/ have a wide range his application and his quality is different according to employ. The Standard Platinum Resistance Thermometer /SPRT/ has highest requirements on quality. Geometrical parameters and materials requirements for construction dimension of Primary Standard Platinum Resistance Thermometers /PSPRT/ have a long time developed result for uniformity of calibration device in oll metrological laboratory. This dimension is important conserve for international compare the International Temperature Scale /ITS/ [2]. The stability of PSPRT have big significance for accuracy of International Temperature Scale 1990 /ITS 90/. We have aim solve long time stability of PSPRT. The stability is one from fundamental requirement of quality PSPRT. This requirement is condition for unity, exactness and accuracy of ITS 90 in world. ITS 90 have strict requirements on purity and streinfree of platinum wire for Primary Standard Resistance Thermometer sensor. The purity of platinum PSPRT is express with relation of resistance et the temperature 0.01°C and at temperature 961.78°C. For PSPRT is acceptable platinum wire which purity is express with relations:

$$W/961.78°C/ \geq 4.2844$$

Necessary is that this purity must remain during application of platinum sensor. During use of PSPRT is the platinum expose mainly contaminated Si with which the Pt create chemical conection PtSi, Pt_5Si_2, Pt_3Si_2, Pt_4Si_3, Pt_2Si_2, $PtSi_{12}$, rich silicides alloies and additions between the crystals. These alloies and additions cause the platinum sensor unstable with regard to structure and stability of resistance coefficient. With this heat process we preparation platinum wire fulfil this condition.

2 CRYSTALLINE STRUCTURE OF Pt WIRE

The platinum wire is fundamental material for construction of PSPRT sensor. The sensor is part of the thermometer where change of the resistance on temperature is important requirement for replaying the temperature scale. These wires are produce from clean platinum with technology of drawing. The wires have crystalline structure deform moulding with drawing and stabilized by annealing. In real crystals exist more or less irregularity on building crystalline lattice what are defect of crystalline lattice. Physical and technical property of crystals relates with theirs fundamental composition and structure. Frequent defect of crystalline lattice is vacant place in point crystalline lattice or locates atoms, ions or molecules between lattice space.

Temperature load of thermometer sensor brings about increase of platinum crystals and lowering the potential energy in the structure of platinum. At the growth of platinum crystals the impurity wander in platinum wire [3]. This process changes the resistance coefficient of sensor wire. We solution heat technological process which create clean and stabil platinum wire for thermometer

sensor. We have process-technological procedure for cleaning platinum and create such crystalline structure of platinum that is resist against contamination. The process is approximately exponential in relation temperature to time [4]. The electrical coefficient changes at the same time. Theoretical we must have crystal-crystalline lattice without defect, without impurity. In this way construct thermometer sensor wire will be stable and his resistance coefficient will be not change.

The Pt wire for stable thermometer sensor is on Fig. 1b. On the figure is the structure of Pt wire with long cut. The line electron microscopy in long cut the Pt wire show three crystals. The crystallized grains is about 0.7mm large. On the Fig.1a is the spectrum of purity from boundary grains.

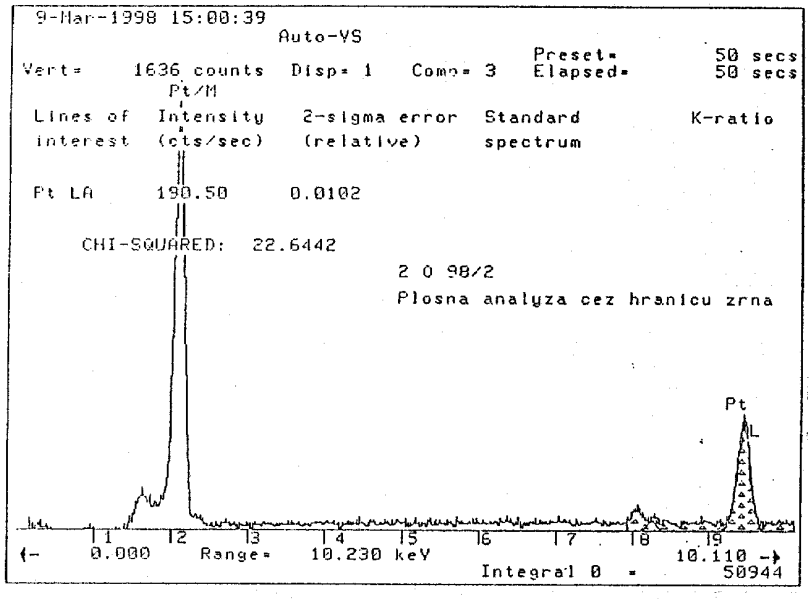

Fig.1a,The spectrum - surface analysis from boundary grains on long cut on Fig.1b.

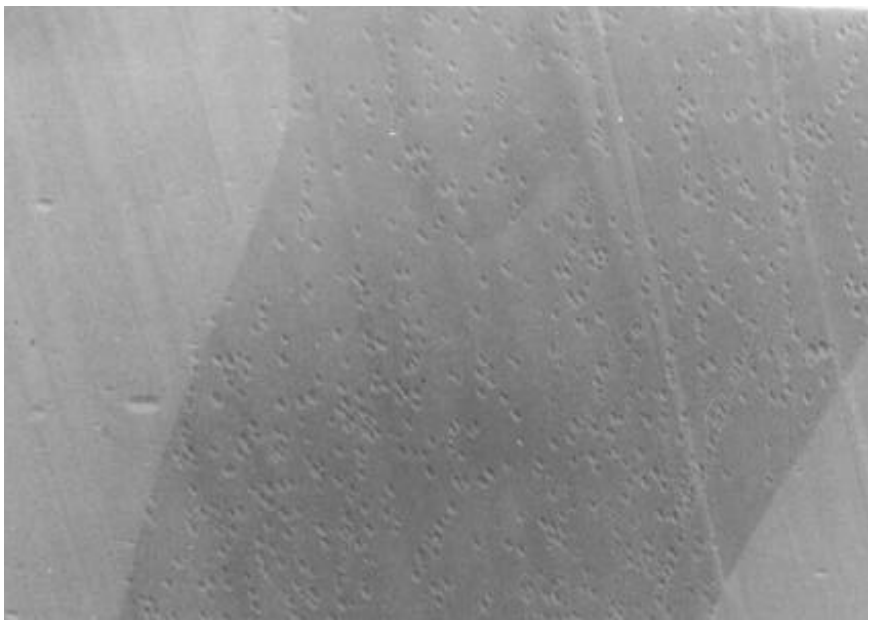

Fig.1b, The structure in microsection of Pt wire, long cut, line microscopy, three grains.

The spectrum of purity analysis between boundary of crystals on graph not contains impurity. Similarly is spectrum analysis in the crystals. It signify that impurity was squeezing-aut from crystals on the surface Pt wire. Et the “Technology Procedure of Recrystallization Annealing of platinum Wire” (page 139 report of project 93 016 Slovak and NIST Primary Standard Thermometer, Slovak University of Technology, MtF Trnava, December 1998 [1]) we achieve thermometer sensor with crystalline lattice without defect and impurity.

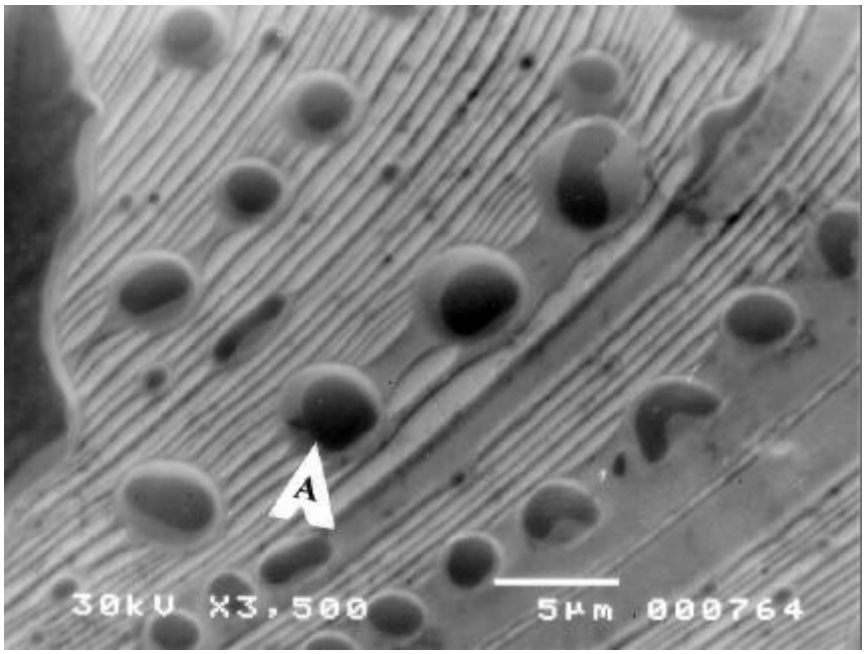

Fig.2a,The elements of impurity on surface, line electron microscope.

The figure Fig.2a indicates the impurity on the surface of wire. These impurities are from within of wire. In original interior of wire is atoms and molecules impurities in crystals lattice and intermediate of crystals. On figure Fig.2b show of point –A spectrum analysis of impurity issue from original interior of wire.

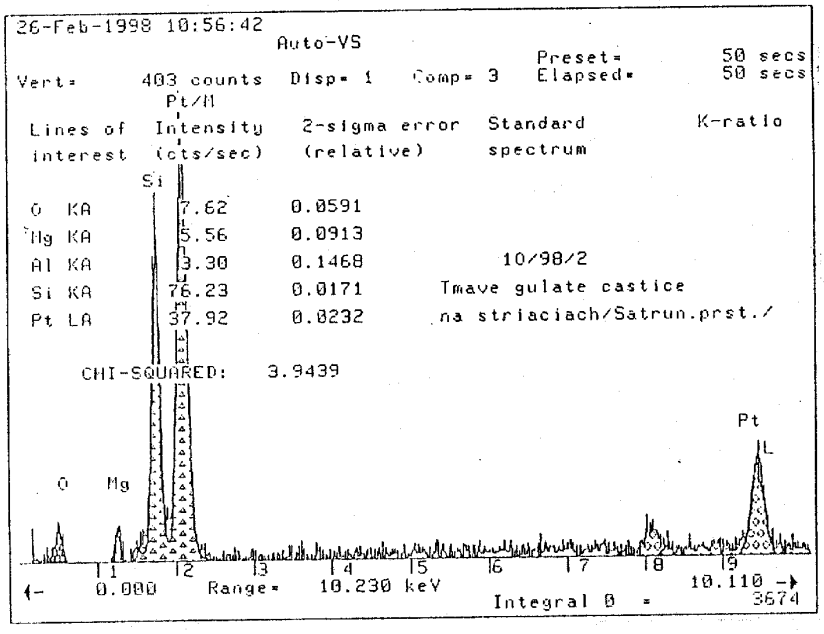

Fig.2b, The spectrum from impurity – A on surface Fig.2a, point analysis.

For test of platinum sensing element was prepared thermometer sensor VOT 01/99. The wire 4N5 was fixed on skeleton obtained from Hart Scientific, Inc. USA. Pt wire 4N5 was manufactured according “Technology Procedure of Recrystalisation Annealing of Platinum Wire”. The wire was straighten and subsequently bifilar wound on skeleton. The thermometer sensor-skeleton with wounded wire was insert to protection tube from Isothermal Technology Ltd., England. The measure uncertainty of sensing element in triple point of water was ± 2 to 3.10^{-4} K what was stability of water triple point cell 273.16 ± 2 to 3.10^{-4} K.After annealing in 1080 °C three hours three times uncertainty was Same.

3 THERMOMETER MEASUREMENT

The thermometer VOT 01/99 with resistance $R_{0.01}$ =1.128 990 1 ohms
Bank water triple point cells with uncertainty 273.16±2 to 3.10^{-4} K.

Measurement "ohm"	Annealing at 1080 °C, 3 hours
1, 1.128 990 2	7, 1.128 990 2
2, 1.128 990 0	8, 1.128 990 0
3, 1.128 990 0	9, 1.128 990 1
Annealing at 1080 °C, 3 hours	Annealing at 1080 °C, 3 hours
4, 1.128 990 1	10, 1.128 990 1
5, 1.128 990 2	11, 1.128 990 1
6, 1.128 990 1	12, 1.128 990 2

4 CONCLUSION

"The Technology procedure of recrystallization Annealing of Platinum Wire" is new technology of temperature processing metallic material design a new quality and characteristic of materials. These are way for solution complicated technical problems install new technology. It is way for obtained new constant and quality of materials.

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