Triple alloys of the Pt-Mo-W system as the thermal decomposition products of complex salts

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$[Pt(NH_3)_4]Mo/WO_4$ → Negative thermal expansion [1], Optical properties **?**

→ T~1000 °C, atmosphere → **Pt-Mo, Pt-W** → Promising electrocatalysts for fuel cells with proton exchange membrane [2-5]

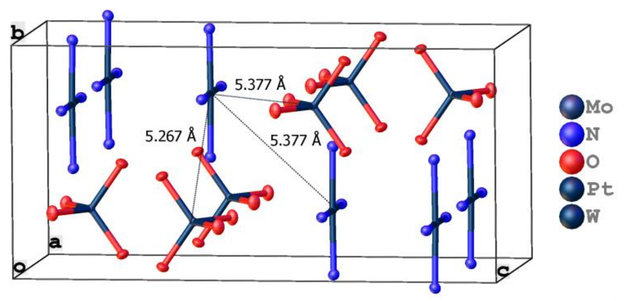
Pt-Mo-W → **?**

The aim: to confirm the phenomenon of negative thermal expansion of precursors; synthesis of a $[Pt(NH_3)_4]Mo/WO_4$ salts solid solution for obtaining triple alloys of the Pt-Mo-W system

Precursors $[Pt(NH_3)_4](MoO_4)_x(WO_4)_{1-x}$

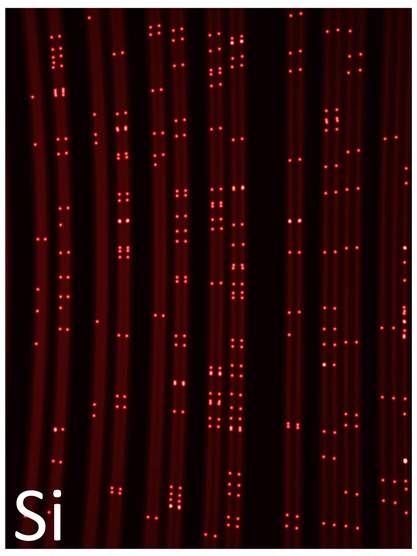
Synthesis: For the synthesis of $[Pt(NH_3)_4](WO_4)_{0.5}(MoO_4)_{0.5}$, 0.0238 g of $Na_2WO_4 \cdot 2H_2O$ and 0.0176 g of $Na_2MoO_4 \cdot 2H_2O$ (molar ratio Mo:W = 1:1) were dissolved separately in a minimum volume of water. The resulting salt solutions were mixed, and then a solution of 0.0559 g $[Pt(NH_3)_4](NO_3)_2$ was added to the resulting mixture. The sedimentation of a white crystalline product was observed in a short time.

Structure
*I*4$_1$/*amd*,
a = 7.4490(3) Å,
c = 15.5150(11) Å,
x = 0.592(7)

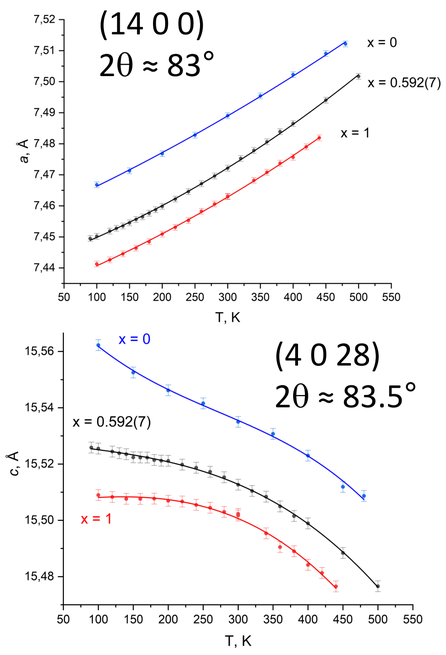


(Bruker D8 Venture, MoKα-излучение, T = 150 K)

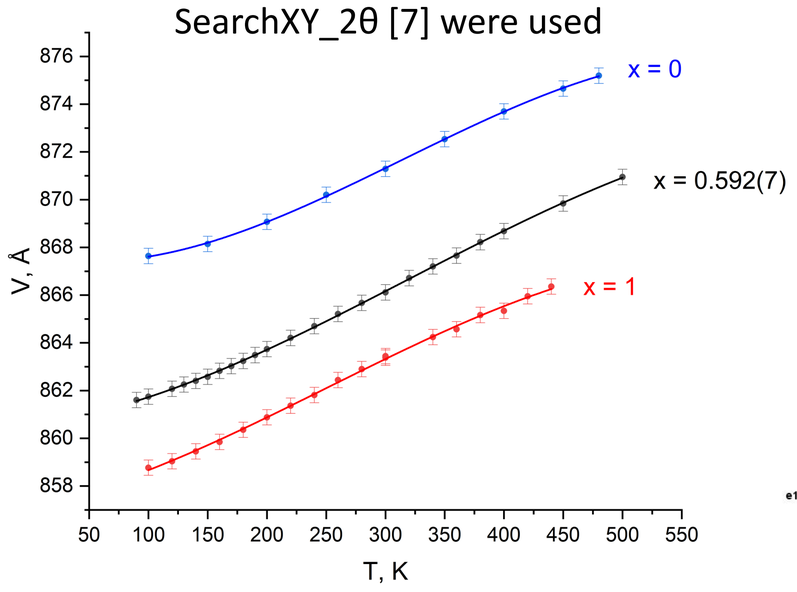
Thermal behavior

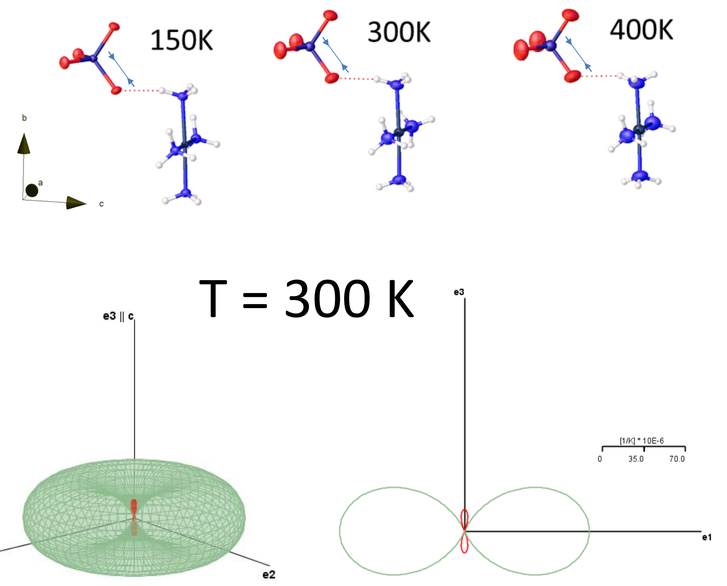


Calibration of detector full area
$2\theta_D$=-83.38°, *D*= 209 mm
SearchXY_2θ [7]



To determine the thermal behavior, the method [6] and the program SearchXY_2θ [7] were used

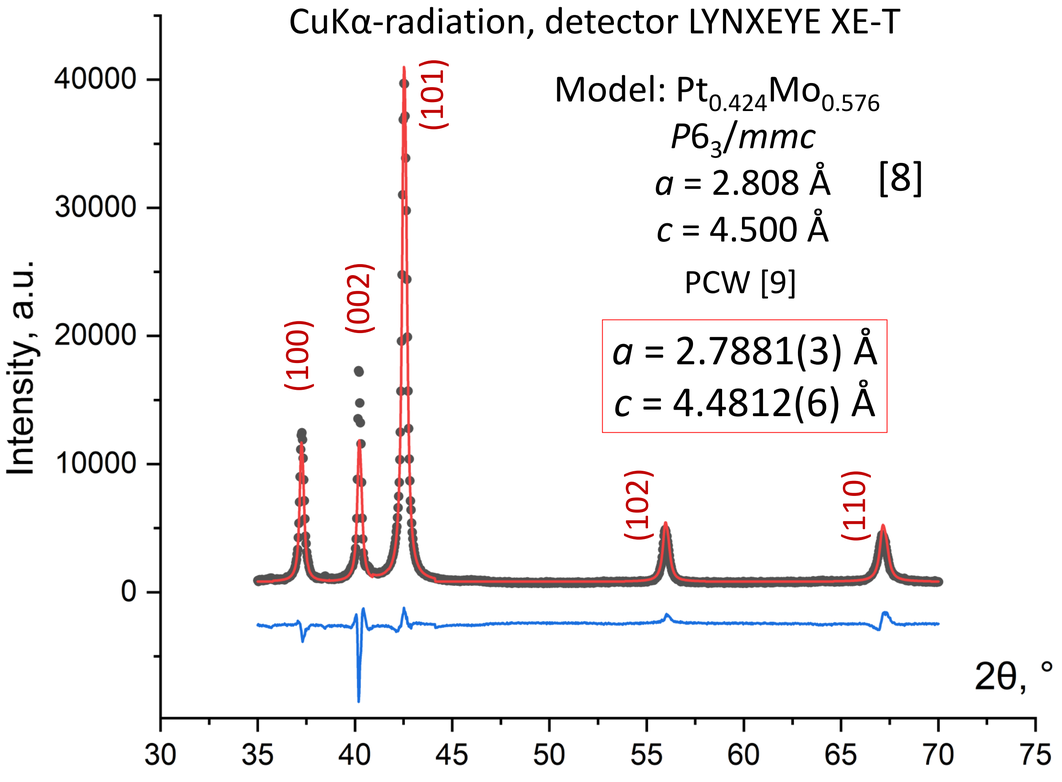




Thermal decomposition product (TDP) of $[Pt(NH_3)_4](MoO_4)_x(WO_4)_{1-x}$

X-ray study

Bruker D8 Advance, Bragg-Brentano scheme,
CuKα-radiation, detector LYNXEYE XE-T



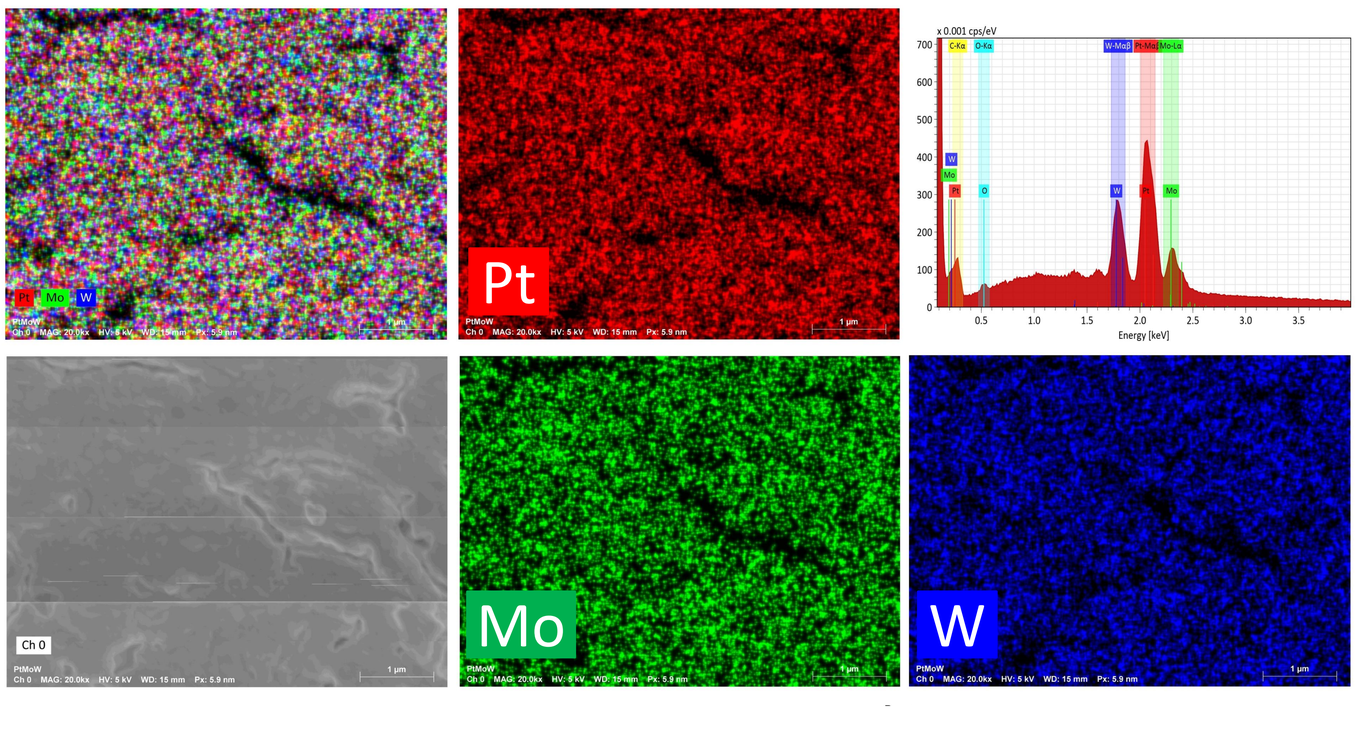
Model: $Pt_{0.424}Mo_{0.576}$
*P*6$_3$/*mmc*
a = 2.808 Å [8]
c = 4.500 Å
PCW [9]

a = 2.7881(3) Å
c = 4.4812(6) Å

It is shown that TDP is a single-phase product of a hexagonal system

Scanning electron microscopy

JEOl JSM 6700FCM, detector Bruker XFlash 6160



TDP is a homogeneous product with an average composition of $Pt_{0.47}Mo_{0.34}W_{0.19}$

Conclusion. It was found that during co-crystallization of a number of salts, a solid solution $[Pt(NH_3)_4](MoO_4)_x(WO_4)_{1-x}$ with a possible spread of *x* values from 0.5 to 0.6 was obtained. During thermal decomposition of a single crystal with *x* = 0.592(7), the formation of a single-phase homogeneous product containing metallic HCP-phase of approximate composition of $Pt_{0.47}Mo_{0.34}W_{0.19}$ is shown.

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1. Lagunova V. I. et al. // Russian Journal of Inorganic Chemistry. – 2020. – Vol. 65. – P. 1566-1570.
2. Kim Y. et al. // International Conference on Extreme Ultraviolet Lithography. – 2022 . – Vol. 12292.
3. Zhang K. et al. ACS Energy Letters. – 2022. – Vol. 7(10) – P. 3329-3336.
4. Wang P., Cui H., Wang C. // Chemical Engineering Journal. – 2022. – Vol. 429. – P. 132435.
5. Lagunova V. et al. // International Journal of Hydrogen Energy. – 2022.
6. Serebrennikova P. C. et al. // Journal of Structural Chemistry. – 2021. – Vol. 62(5). – P. 682-691.
7. Panchenko A. V. et al. // Journal of Structural Chemistry. – 2022. – Vol. 63(10). – P. 1662-1669.
8. Ocken H., Van Vucht J. H. N. //Journal of the Less Common Metals. – 1968. – Vol. 15(2). – P. 193-199.
9. Kraus W., Nolze G. //Journal of applied Crystallography. – 1996. – Vol. 29(3). – P. 301-303.