Brief information about the project

Name of the project	AP19177332 «Properties of two-dimensional transition metal dichalcogenides prepared by vacuum stoichiometric melting and chemical vapor deposition (CVD) methods.»
Relevance	Development of methods for obtaining two-dimensional transition metal dichalcogenides in a short time and in a cost-effective way and taking into account the advantages of using the obtained two-dimensional structures in electronics and optoelectronics.
Purpose	Investigation of the optical and electrical properties of two-dimensional transition metal dichalcogenides obtained by stoichiometric melting in vacuum and chemical vapor deposition (CVD) methods.
Objectives	1. Achieve the technology of choosing the optimal parameters for obtaining chemically pure transition metal dichalcogenides MX_2 (M=Mo,W; X=Se,S) by the stoichiometric vacuum melting method and vacuum chemical precipitation methods of gas phase. 2. Mounting of two-dimensional structures with a thickness of several atomic layers on Si or SiO_2 mats by the method of micromechanical separation of the resulting MX_2 crystals 3. Study of the thickness of the dependent luminescence of two-dimensional structures obtained by the method of micromechanical separation using a combined light-scattering device. 4. Creation of contacts from Al or Au elements on the VUP-5 device to two-dimensional structures based on MX_2 of various thicknesses mounted on Si or SiO_2 substrates. 5. Current-voltage characteristic of contact two-dimensional Al or Au structures, photosensitivity, etc. study of electrical and optical properties. 6. Repetition of the modification of two-dimensional structures based on $MoSe_{1-x}S_x$ and $WSe_{1-x}S_x$, as in tasks 1-5 above, to obtain materials with high light sensitivity required for electronics and optoelectronics.
Expected and achieved results	The two-dimensional nanostructures obtained in the project, consisting of MX_2 compounds (M=Mo,W; X=Se,S), increase the light-sensing capabilities of devices used in electronics and manufacturing, due to their optical and electrical properties, increase the power of devices due to the current density emissions, light emitting diodes due to light emitting properties, etc. Applications in the fields of science and technology will be considered. In turn, patents will be granted to materials with superior performance. For example, based on articles published in the latest issue of the journal Nature on the two-dimensional structure of WSe_2, a transistor with a 100-nm bilayer structure channel in the open state has a current density above 1.0 mA μm^{-1} and a resistance value of less than 1 kOhm. Given these and other properties mentioned

	above, it can be seen that they are very important materials for science and technology.
Research team members with their identifiers (Scopus Author ID, Researcher ID, ORCID, if available) and links to relevant profiles	1. Aitzhanov M.B. Scopus ID: 55803827100, Researcher ID: ABF-3479-2021, ORCID ID: **0000-0002-3681-2727.** Aitzhanov, Madi B. - Author details - Scopus Preview Madi Aitzhanov - Web of Science Core Collection Madi Aitzhanov (0000-0002-3681-2727) - ORCID
List of publications with links to them	1. Madi Aitzhanov, Nazim Guseinov, Renata Nemkayeva, Yerulan Sagidolda , Zhandos Tolepov, Oleg Prikhodko and Yerzhan Mukhametkarimov. Growth and Liquid-Phase Exfoliation of GaSe1−xSx Crystals. Materials 2022, 15, 7080. (IF=3.748, Q2, CiteScore percentile 63%, https://doi.org/10.3390/ma15207080) 2. Darmenkulova, M.B., Aitzhanov, M.B., Zhumatova, S.A., Ibraimov, M.K., Sagidolda, Y. Change of Optical Properties of Carbon-Doped Silicon Nanostructures under the Influence of a Pulsed Electron Beam. Journal of Nanotechnology, 2022, 2022, 1320164 (Q4, CiteScore percentile 65%, https://doi.org/10.1155/2022/1320164) 3. Paltusheva, ZU, Alpysbaiuly, N, Kedruk, YY, Zhaidary, AD, Aitzhanov, MB, Gritsenko, LV, Abdullin, KA, Photocatalytic activity of zinc oxide - graphene oxide composites//BULLETIN OF THE UNIVERSITY OF KARAGANDA-PHYSICS, Volume2 Issue106 Page102-110, 2022-07-14 (Q4, https://doi.org/10.31489/2022PH2/102-110) 4. Prikhodko, O.Yu., Aitzhanov, M.B., Gusseinov, N.R., ...Nemkayeva, R.R., Mukhametkarimov, Y.S. Photocatalytic activity of liquid-phase exfoliated gallium selenide flakes. Chalcogenide Letters, 2021, 18(12), pp. 777–781 (IF=0.855, Q4, CiteScore percentile 22%) 5. Aitzhanov, M., Guseinov, N., Nemkayeva, R., ...Prikhodko, O., Mukhametkarimov, Ye. InSe Crystals Obtained by Stoichiometric Fusion for Optoelectronic Device Application | Кристали InSe, отримані стехіометричним плавленням, для застосування в оптоелектронних пристроях Journal of Nano- and Electronic Physics, 2021, 13(5), pp. 1–5 (CiteScore percentile 20%, https://doi.org/10.21272/jnep.13(5).05037) 6. Kuanyshbekov, T.K., Akatan, K., Kabdrakhmanova, S.K., Nemkaeva R., Aitzhanov M., Imasheva, A., Kairatuly, E. Synthesis of graphene oxide from graphite by the hummers method, Oxidation Communications, 2021, 44(2), pp. 356–365, (CiteScore percentile 22%, https://scibulcom.net/en/article/mckdusEj82rYBfoXEClD) 7. Mussakhanov, D.A., Tulegenova, A.T., Lisitsyn, V.M., ...Kozlovsky, A., Michailov, Y.I. Structural and luminescent characteristics of YAG phosphors synthesized

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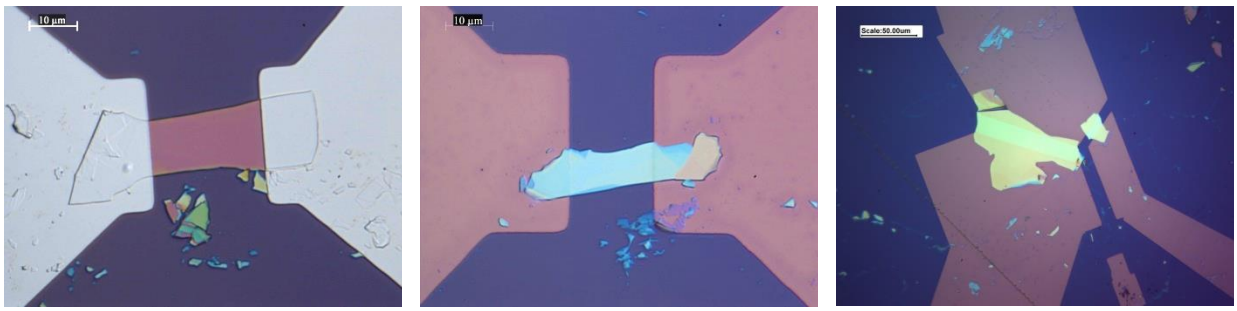
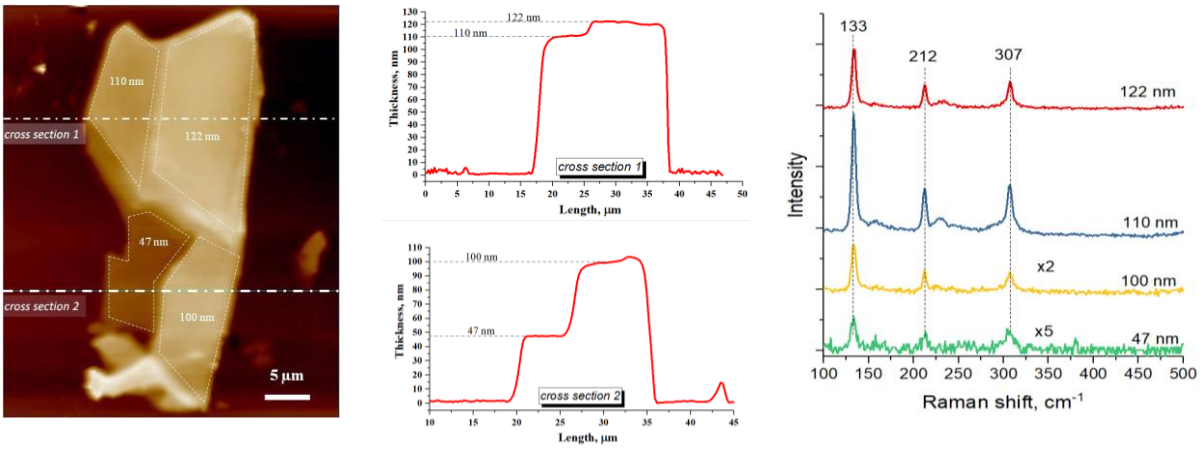
Patents	-



а) б) в)

a-Aluminum contacts; B-copper contacts; B-gold contacts

Figure 1-images of samples with different contacts under an optical microscope



а) б) в)

a-AKM image; B-thickness profile; B-Raman spectra of two-dimensional nanocrystals of different thicknesses

Figure 2-results of the study of the thickness and structure of two-dimensional nanocrystals