## Summary report on research accreditation

### I. General information

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|---|---|
| Name of organization | **Institute of Applied Physics** |
| Organization type (*to underline*) | Research institution  Higher education institution  Ministerial research institute |
| Research direction (s) of organization | Theoretical and experimental research in the field of physics and physico-chemistry of condensed matter: crystalline, non-crystalline and nanostructured materials, atoms and nuclei; electronic and quantum optics, development of advanced technologies and multifunctional electronic, optoelectronic and photonic devices; application of electricity in order to intensify the heat and mass transfer processes, cavitation, electrofloating and electroplasmolysis; modification of the surfaces of materials by electrophysical and electrochemical methods; development of advanced technologies and techniques |
| Correlation with strategic research direction (s) of activity in the field of science and innovation for 2013-2020 | Innovative materials, technologies and products |
| Evaluated period | 2012 - 2016 |
| Web of organization | http://www.phys.asm.md/ |

### II. Research capacity (annual average for evaluated period)

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|---|---|---|---|---|---|---|
| Total number of employees | **214.4** | | | | | |
| Number of scientific researchers | **150.65** | | | | | |
| Number of researchers who possess honorific titles, scientific degrees, scientific and scientific-didactical titles | ASM full members **6** | ASM corresp. Members **1** | Professor **19** | Associated Professor **42** | Dr.hab. **25.2** | Dr. (PhD) **87** |
| Number of researchers involved in international projects | European Commission Programmes **13.2** | United Nations Programmes and Funds **0** | Bilateral Programmes financed from the national budget **49** | Others **20.6** | | |
| Number of young researchers (under 35 years old) | PhD students **14** | | Others **24** | | | |
| Financial resources - revenues (thousand MDL) | Public budget **15833.5** | | Special means **4623.0** | | | |
| Categories of special means (thousand MDL) | National **1066.5** | | International **3556.5** | | | |
| Distribution of expenditures (thousand MDL) | Salary **14539.3** | Procurement of scientific equipment **403.9** | Traveling for scientific purposes (travel, accommodation, per-diems, etc.) **821.3** | Other **2535.9** | | |

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|---|---|
| List of 3 basic research methods, equipments, technologies (per accredited field) | 1. Crystallography research (Difractometer X Calibur E "Oxford Diffraction").<br>2. Holographic registration and Digital Holographic Microscope.<br>3. Crystal growth and materials characterization. |
| List of provided scientific services | - Tests at "Labmet" Laboratory, accredited within the Accreditation System of the Republic of Moldova, which was active at the IFA until 2013. During the period 2012-2013, 150 expert assessments of the mechanical properties of materials and products of plastics were performed.<br>- Developing the technology of forming bronze coatings on the working surfaces of the suspension bushings.<br>- Electrochemical processing of metallic objects on two sides and in volume.<br>- Optimization of electrolytic parameters for electrochemical pulse dimensional electrochemical processing of engine and gas turbine blades and the determination of their permissible level in the exploitation process.<br>- Testing a solar collector.<br>- Development of materials from chalcogenide glasses, description of technological processes for their realization and production of massive samples and thin layers.<br>- Elaboration of new recording media based on polymers.<br>- Elaboration of concentrators to stimulate the efficiency of photovoltaic cells.<br>- Structure measurements with X-rays. |
| List of editorial activities | - Editing of scientific journal "Surface Engineering and Applied Electrochemistry", (Pleiades Publishing), ISSN 1068-3755 (print), ISSN 1934-8002 (online)<br>- Editing of the conference abstract books (MSCMP-2012, 2014, 2016) |

## III. Distribution of the number of research projects and themes during the evaluated period

| | | | | | |
|---|---|---|---|---|---|
| ASM institutional projects | 2012<br>**5** | 2013<br>**5** | 2014<br>**5** | 2015<br>**10** | 2016<br>**10** |
| ASM projects in the frame of State Programmes | 2012<br>**1** | 2013<br>**1** | 2014<br>**1** | 2015<br>**1** | 2016<br>**1** |
| ASM technological transfer projects | 2012<br>**1** | 2013<br>**0** | 2014<br>**0** | 2015<br>**0** | 2016<br>**0** |
| ASM projects for equipment procurement | 2012<br>**1** | 2013<br>**0** | 2014<br>**0** | 2015<br>**0** | 2016<br>**0** |
| ASM projects for young researchers | 2012<br>**3** | 2013<br>**1** | 2014<br>**4** | 2015<br>**6** | 2016<br>**3** |
| ASM projects in the frame of bilateral programmes | 2012<br>**4** | 2013<br>**11** | 2014<br>**17** | 2015<br>**13** | 2016<br>**9** |
| International projects/grants | 2012<br>**6** | 2013<br>**8** | 2014<br>**10** | 2015<br>**11** | 2016<br>**10** |
| List of 3 representative international projects/grants | 1. FP7-PEOPLE-2009-IIF/909407. Induced electrodeposition of nanostructures as nanowires and nanotubes consisting of cobalt-based multilayers for MEMS applications – NANOALLOY (2013 – 2014). | | | | |

| | |
|---|---|
| | 2. FP7-AAT.2012.6.3-1./335091. Tangential Impulse Detonation Engine – TIDE (2013 – 2016).<br>3. 687328 H2020-TWINN-2015 Twinning. Boosting the scientific excellence and innovation capacity in digital holographic microscopy of the Institute of Applied Physics of the Academy of Sciences of Moldova (2016-2019). |

| Research contracts | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|
| | **2** | **8** | **2** | **4** | **2** |

| | |
|---|---|
| List of 3 representative research contracts | 1. TOPAZ Plant (Chisinau), 2013. Optimization of electrolyte parameters for electrochemical pulse dimensional machining of gas turbine engines and gas turbine blades and determination of their permissible level in the exploitation process.<br>2. INCDO (Romania), 2013. Development of materials, description of the technological processes for their realization and production of samples from these materials.<br>3. TOPAZ Plant (Chisinau), 2016. Elaboration of the technical documentation and manufacture of the pilot models of four types of applicators for the electric spark alloying. |

## IV. Scientific publications

| Total number of publications abroad | Books | Chapters in books | Journal papers | Conference abstracts |
|---|---|---|---|---|
| | **4** | **16** | **748** | **375** |

| Total number of publications in ISI journals and books | Books | Chapters in books | Journal papers |
|---|---|---|---|
| | **0** | **0** | **541** |

| Total number of publications in the country | Books | Chapters in books | Journal papers | Conference abstracts |
|---|---|---|---|---|
| | **1** | **0** | **250** | **722** |

List of 5 representative publications (per accredited field)

1. **Melnic, E.;** Coropceanu, E.B.; Forni, A.; Cariati, E.; **Kulikova, O.V.; Siminel, A.V.; Kravtsov, V.Ch.; Fonari, M.** Discrete Complexes and One-Dimensional Coordination Polymers with [Cu(II)(2,2′-bpy)]2+ and [Cu(II)(phen)]2+ Corner Fragments: Insight into Supramolecular Structure and Optical Properties. *Crystal Growth Design* 2016, 16, 6275 (IF: 4.425).
2. **Mitioglu, A.A.;** Plochocka, P.; Granados Del Aguila, Á.; Christianen, P.C.M.; Deligeorgis, G.; **Anghel, S.; Kulyuk, L.;** Maude, D.K. Optical investigation of monolayer and bulk tungsten diselenide ($WSe_2$) in high magnetic fields. *Nano Letters* 2015, 15, 4387 (IF: 13.592).
3. Wang, Z.; Schmidt, M.; Fischer, J.; **Tsurkan, V.;** Greger, M.; Vollhardt, D.; Loidl, A.; Deisenhofer, J. Orbital-Selective Metal–Insulator Transition and Gap Formation above TC in Superconducting $Rb_{1-x}Fe_{2-y}Se_2$. *Nature Communications* 2014, 5, 3202 (IF: 10.742).
4. **Simashkevich, A.; Serban, D.; Bruc, L.; Curmei, N.;** Hinrichs, V.; Rusu, M. Indium tin oxide thin-films prepared by vapor phase pyrolysis for efficient silicon based solar cells. *Thin Solid Films* 2016, 610, 35 (IF: 1.761).
5. **Moskalenko, S.A.; Podlesny, I.V.; Dumanov, E.V.;** Liberman, M.A. Two-dimensional cavity polaritons under the influence of the perpendicular strong magnetic and electric fields. The gyrotropy effects. *Solid State Communications* 2015, 222, 58 (IF: 1.897).
6. **Baznat, M.; Gudima, K.;** Sorin, A.; Teryaev, O. Femto-vortex sheets and hyperon polarization in heavy-ion collisions. *Physical Review C*

| | |
|---|---|
| | 2016, 93, 031902 (IF: 3.146). |
| List of 5 citations | 1. Rational Design of Single-Ion Magnets and Spin Qubits Based on Mononuclear Lanthanoid Complexes. *Inorganic Chemistry*, 2012, 51, 12565, 97 citations.<br>2. NMR Study in the Iron-Selenide $Rb_{0.74}Fe_{1.6}Se_2$: Determination of the Superconducting Phase as Iron Vacancy-Free $Rb_{0.3}Fe_2Se_2$. *Physical Review Letters*, 2012, 108, 237002, 95 citations.<br>3. Nanoscale Layering of Antiferromagnetic and Superconducting Phases in $Rb_2Fe_4Se_5$ Single Crystals. *Physical Review Letters*, 2012, 109, 017003, 57 citations.<br>4. Optical manipulation of the exciton charge state in single-layer tungsten disulphide *Physical Review B*, 2013, 88, 245403, 62 citations.<br>5. Free-to-bound recombination in near stoichiometric $Cu_2ZnSnS_4$ single crystals. *Physical Review B*, 2012, 86, 045206, 52 citations. |

## V. Innovation outputs

| | | | |
|---|---|---|---|
| Total number of patents | Registered in the country<br>**68** | Registered abroad<br>**2** | Implemented<br>**0** |
| Total number of new developed methods and technologies | Registered<br>**36** | Non-registered<br>**9** | Implemented<br>**4** |
| Total number of new scientific products | Registered<br>**356** | Non-registered<br>**10** | Implemented<br>**8** |
| List of 5 representative innovation outputs (per accredited field) | 1. **I.Culeac, I.Nistor, M.Iovu, A.Andrieş,** A.Buzdugan, **P.Petrenko, V.Ciornea.** Fiber optic interferometric sensor for ionizing radiation recording. Patent MD 412, 31.03.2012.<br>2. E.Coropceanu, **V.Parşutin, N.Şoltoian, N.Cernîşeva, A.Covali, L.Croitor,** I.Bulhac, O.Bologa, **M.Fonari**. Inhibitor of steel corrosion in water. Patent MD 4330 30.09.2015.<br>3. **V.Gonciaruc, A.Paramonov, M.Bologa,** V.Șchileov**, A.Policarpov, A.Covali.** Hydrogen production process and reactor. Patent MD 885, 31.09.2015.<br>4. **S.Belevschi, A.Dicusar,** A.Shuliman, **J.Bobanova**, **S.Iuşcenco, T.Borţoi.** Process for the preparation of the aqueous gluconate electrolyte for the deposition of Co-W nanocrystalline coatings. Patent MD 4331, 30.09.2015.<br>5. V.Zahvalinskii, E.Piliuk, **D.Şerban, A.Simaşchevici, L.Bruk.** Photovoltaic structure. Patent MD 4339, 31.01.2016. | | |

## VI. Other outputs

| | | | |
|---|---|---|---|
| Total number of scientific outputs for central and local authorities (draft of law, strategies etc.) | **0** | | |
| Total number of scientific outputs for educational institutions | Handbooks for higher education<br>**2** | Handbooks for pre-university institutions<br>**19** | Number of researchers – supervisors of license and master theses<br>**34** |

## VII. Major scientific and innovation achievements

| | |
|---|---|
| Short description of main scientific results and their confirmation (by awards, citations, development of international projects etc.) | 1. *Néel-type skyrmion lattice with confined orientation in the polar magnetic semiconductor $GaV_4S_8$*. The main essence of the work is the discovery of a new arrangement of Neel-skyrmion spines with radial spindle rotation. Skyrmion spinning materials are an advantage for the design of new generation performance information devices due to nanoscale dimensions and the ability to manipulate their structure with low intensity fields. Confirmation: Paper in *Nature Materials*, 2015, 14, 1116, IF: 36,503, 48 citations.<br>2. *Iridates from the molecular side*. For the first time an $IrF_6$ molecule demonstrating monomolecular magnetic properties was selected. The theoretical model explaining this phenomenon has been developed. As a rule, iridium compounds are extensive space structures, and the isolation of $[IrO_6]^{8-}$fragment in iridium oxide is chemically impossible. Synthesis of a single molecule of $[IrF_6]^{2-}$ was performed experimentally and the behavior of this molecule as a monomolecular magnet was highlighted. Confirmation: Paper in *Nature Communications*, 2016, 7, 12195, IF: 11,329, 2 citations.<br>3. *Collective quantum dot inversion and amplification of photon and phonon waves*. The possibility of steady-state population inversion in a small sample of strongly driven two-level emitters such as quantum dots in microcavities was demonstrated. The absorption profiles of photons and phonons show marked novel features such as gain instead of transparency and absorption reversed to gain, respectively. Confirmation: Paper in *Physical Review B*, 2013, 88, 125306, IF: 3,767, 7 citations.<br>4. *Polarized Raman scattering study of kesterite type $Cu_2ZnSnS_4$ single crystals*. The zone–center optical phonons of $Cu_2ZnSnS_4$ (CZTS), which is most usually examined in active layers of the CZTS based solar cells, are studied by polarized resonant and non-resonant Raman spectroscopy in the range from 60 to 500 $cm^{-1}$ on an oriented single crystal. The phonon mode symmetry of 20 modes from the 27 possible vibrational modes of the kesterite structure is experimentally determined. Lyddane-Sachs-Teller relations are applied to estimate the ratios of the static to high-frequency optic dielectric constants parallel and perpendicular to c-optical axis. Confirmation: Paper in *Scientific Reports*, 2016, 6, 19414, IF: 5,228, 12 citations.<br>5. *Development of Digital Holographic Microscopy*. The overall aim of the project is to boost the scientific excellence and innovation capacity in digital holographic microscopy of the Institute of Applied Physics by creating a network with the high-quality. Confirmation: H2020 Project 687328 H2020-TWINN-2015 Twinning.<br>6. *Elaboration of technology for fiber-optic system of guard signalling*. A model of a security system to protect against perimeter interventions of objects of strategic importance based on the use of optical fibers was developed and executed. The system is more efficient compared to the existing traditional systems, using copper wires, sensors, or video cameras. Confirmation: Gold Medal at the International Invention Show INOVA, Croatia, 2014. |

| Number of researchers invited as speakers at international | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|
| | **9** | **0** | **10** | **3** | **3** |

| | | | | | |
|---|---|---|---|---|---|
| conferences | | | | | |
| Short description of technological transfer and innovation results and their certification by implementation | • *Elaboration of a technology for printing quasi-holograms on samples of precious metals and a portable device for identifying fake signs*. Technology development was carried out under the Technological Transfer Project no. 12.824.15.166T of 01.07.2012. The optical set-up of the "Nautilus" laser processing system was developed with the use of quasiholographic technology to increase the level of protection of the state mark. Several patented innovations have been staged: quasiholographic technology for marking precious metal objects; portable laser device for control of the state trademark; digital software for creating holographic image. The innovations were implemented at the State Chamber for the Marking Supervision of the Republic of Moldova.<br>• *Technology of electroplasmolysis processing of vegetable raw materials*. The use of the IFA production stream electroplasmizer ensures the increase of apple juice extraction by up to 4.5%. The technology was implemented in 2012 at the "ECOVIT" SRL (Ungheni, Republic of Moldova).<br>• *Coating technology for refurbishing the interior surfaces of the bushings of the "Cubota" excavator suspension system (Japan)*. The cost of the work is well below the cost of their import from Japan, which has led to increased economic efficiency. The technology was implemented at "Naiman-Com" SRL (Chișinău) in 2013.<br>• *Elaboration of technologies of electric sparks and electrochemical pulse dimensional alloying for metal surfaces hardening:* modeling of the electrochemical processing of two-sided and volume metallic objects, optimization of electrolyte parameters for pulse dimensional electrochemical processing of engine and gas turbine blade and determination of their permissible level in the exploitation process; elaboration of technical documentation and manufacture of pilot models of applicators for the spark alloying installation. The elaborations were implemented at "TOPAZ" Plant (Chișinău) and confirmation by economic research contracts (2013, 2016). | | | | |
| Number of defended dr./dr. hab. theses per year | 2012<br>**6 / 0** | 2013<br>**0 / 2** | 2014<br>**1 / 0** | 2015<br>**4 / 0** | 2016<br>**1 / 0** |

## VIII. Present/further involvement in the Horizon 2020 (FP7)

H2020 Project: 687328 H2020-TWINN-2015 Twinning "*Boosting the scientific excellence and innovation capacity in digital holographic microscopy of the Institute of Applied Physics of the Academy of Sciences of Moldova"* 2016-2019 (999926.3 EUR).

## IX. Accredited research field and its evaluation by the National Council for Accreditation and Attestation of the Republic of Moldova (very good/good/ satisfactory):

*Condensed matter physics, atoms and nuclei, photonics, material science, electrotechnologies* – **very good**

**X. Category (A/B/C) attributed by the National Council for Accreditation and Attestation of the Republic of Moldova to the organization:**

**Category A**

**XI. Institutional development actions planned for the next 5 years (maximum ½ page).**

- Involving younger and middle-aged scientific staff with managerial experience in the Institute activities;
- enhancing the efficiency of the Institute's activity as well as increasing the chances of attracting extra-budgetary funds via stimulating performant research;
- increasing the Institute's visibility at national and international levels;
- finding new research areas with marketable results and increasing the number of results with potential for implementation;
- attracting research and production orders from economic agents in order to stimulate the participation of researchers in the implementation of technology transfer projects contributing to the socio-economic development of the country;
- maintaining the actuality of Institute's research topics and promotion of services related to the national economy;
- strengthening the experimental and production Institute's base;
- optimizing existing scientific activities and practices;
- keeping the Institute's scientific traditions.