МОСКОВСКИЙ ПОЛИТЕХ

Integration of TIPS into the Additive Technologies Bachelor's Degree Educational Programme

(Additive Technologies Educational Programme at the university)

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Integration of TIPS into the educational programme
(Additive Technologies Educational Programme at the university)

Content:

- About the university, the educational programme and the graduate department
- Model of the Additive Technologies Educational Programme
- Key modules of the programme
- Case study projects: where is the place for research?

Integration of TIPS into the educational programme
(Additive Technologies Educational Programme at the university)

About the university and the application of 3D-technologies in the curricula

- Moscow Polytechnic University **as a flagship of project-based learning**
- First graduation of young AT specialists in 2018
- First graduation of AT masters in 2020
- **3D-technologies: general engineering and profile disciplines**

Moscow Polytechnic University today:

- Branches: 6
- Total students: 20,000+
- Educational programmes: 275
- Graduate faculties and institutes: 6 + 3
- web: www.mospolytech.ru

Graduating Department of Materials Processing under Pressure and Additive Technologies today:

- Laboratories: 2
- Educational programmes: 4
- Faculty: Mechanical Engineering

МОСКОВСКИЙ ПОЛИТЕХ

Model of the Additive Technologies Educational Programme

Disciplines of the AT educational programme (Moscow Polytechnic University):

PROGRAMME GOAL

Idea =
(creating a concept for a new solution)

design elements;

technology; new concepts

3D-scanning

3D-modeling

Modelling =

product design;

equipment/technology;

3D-printing (AT)

3D-modeling

Technology =

product manufacturing;

technology modes

3D-scanning

Universal technological competence

Model of the Additive Technologies Educational Programme

know and be able to use numerical methods required in AP;

be able to develop and improve production processes of AP;

be able to optimise, including on the basis of bionic design principles, the shape of tools and products;

be able to select equipment for implementing production processes and design production sites in the professional field;

be able to organise R&D for developing projects;

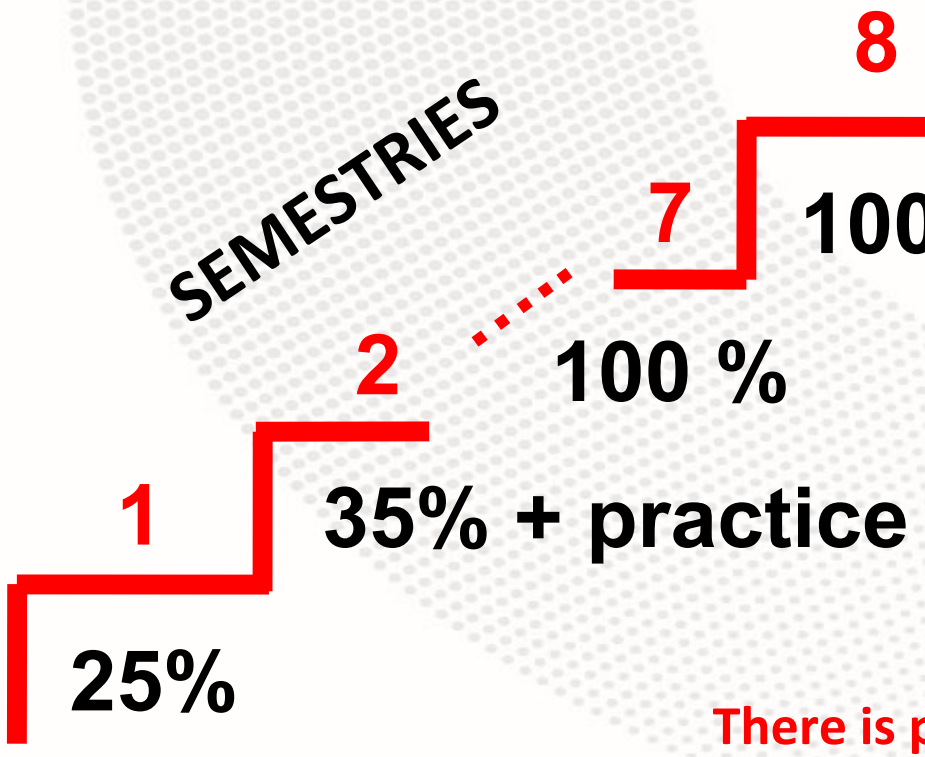
be able to apply specialised software packages for technological modelling and of technology optimisation in the professional field;

be able to develop a project from an idea to a functional prototype in the professional field by oneself and as part of a project team.

Prof. Standard No. 40.159 'Specialist in Additive Technologies', qualification level 5, 6

Model of the Additive Technologies Educational Programme

When does the 'speciality' start?



Технопарк «Слава»

ЦАТ

КАЛИБР ТЕХНОПАРК

ММП имени В.В. Чернышева ОДК

САЛЮТ

ГАЗ группа

РУСАЛ

CAN TOUCH

AMCORE

CYBERCOM

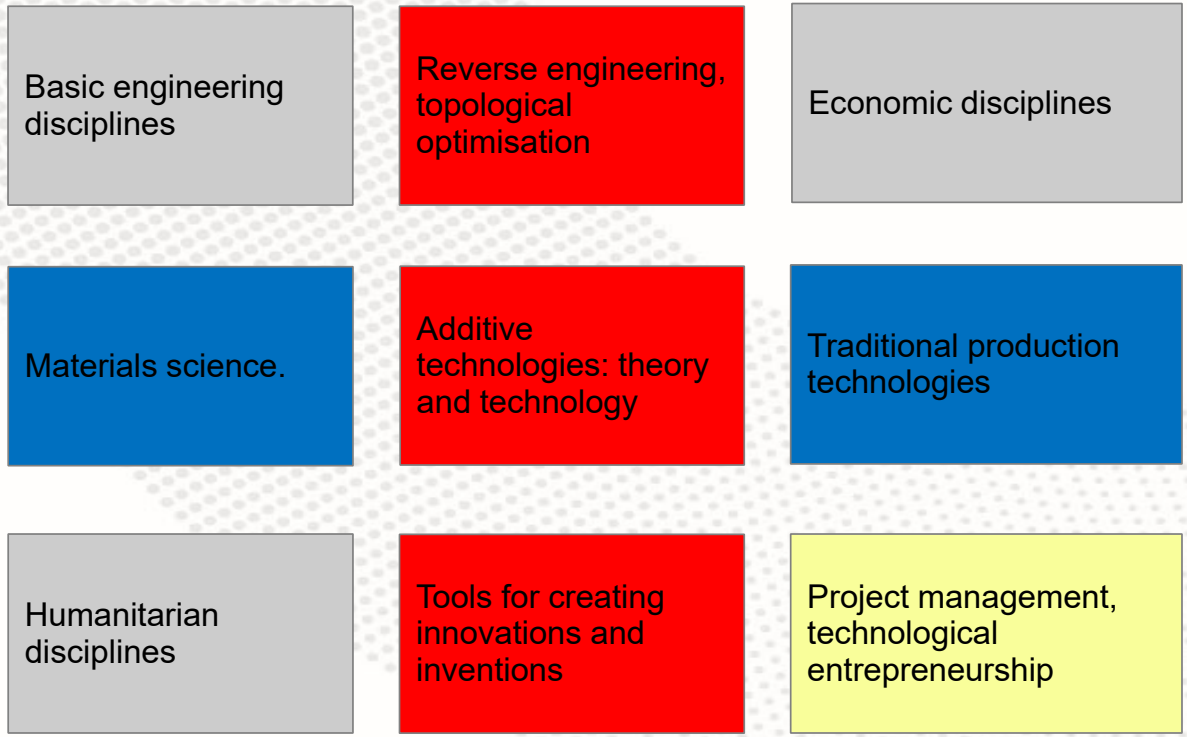
HARZ Labs MATERIALS FOR 3D PRINTING

There is practice in the 1st, 2nd, 3rd, and 4th years

МОСКОВСКИЙ ПОЛИТЕХ

Key modules of the programme

key conceptional blocks of the educational programme



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Key modules of the programme

key blocks of the educational programme

DISCIPLINE BLOCK (key)	Table of Contents (unique competence)
Reverse engineering, topological optimisation	Training in reverse engineering and bionic design using CAD/CAE tools, which is the basis for additive technologies and development of new concepts
Additive technologies: theory and technology	Training in additive technologies, including production stages: from material to product.
Tools for creating innovations and inventions	Training in TIPS methods and tools used to create new products, search for new technical solutions, develop/improve technologies, equipment, and materials.

Key disciplines

Module:

Tools for creating innovations and inventions

	1st year	2nd year	3rd year	4th year
History of innovation and invention	*	-	-	-
Algorithms for solving non-standard problems	*	*	-	-
TIPS methods and tools	-	*	*	-
TIPS+ analytical tools	-	*	*	-
Principles of technical system development	-	-	-	*
Forecasting and expert examination of innovative projects				*
Project activities	*	*	*	*
Copyright and IP protection	-	-	-	*
Filing patent applications in additive manufacturing	-	-	-	*

МОСКОВСКИЙ ПОЛИТЕХ

Key disciplines

Module:

Tools for creating innovations and inventions

	1st year	2nd year	3rd year	4th year
History of innovation and invention	*	-	-	-
Algorithms for solving non-standard problems	*	*	-	-
TIPS methods and tools	-	*	*	-
TIPS+ analytical tools	-	*	*	-

Technical solutions
Effects

Creative imagination development (CID)
TIPS
(part 1: Ideal Final Result (IFR), contradictions, technical systems (TS), etc.)

TIPS
(part 2: PA, Cause-Effect Analysis (CEA), Tr, DA, FA, Algorithm for Inventive Problem Solving (AIPS), resources)

Key disciplines

Module:

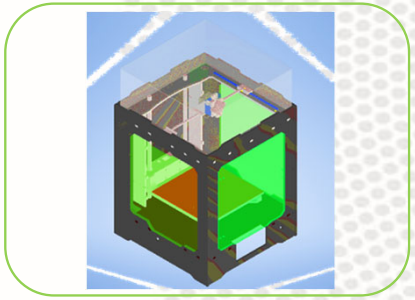
Tools for creating innovations and inventions

	1st year	2nd year	3rd year	4th year
Principles of technical system development	-	-	-	*
Forecasting and expert examination of innovative projects				*
Project activities	*	*	*	*
Copyright and IP protection	-	-	-	*
Filing patent applications in additive manufacturing	-	-	-	*

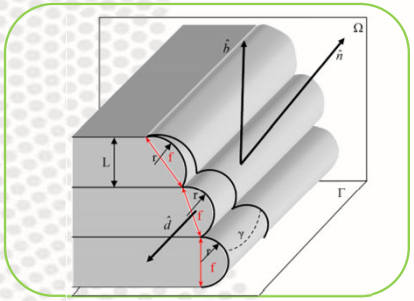
Preparation of the final thesis

МОСКОВСКИЙ ПОЛИТЕХ

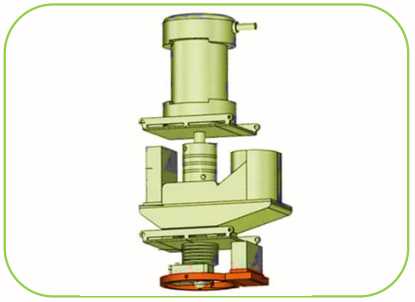
Case study projects: where is the place for research?



Case 1: 3D-printing with low temperature plastics

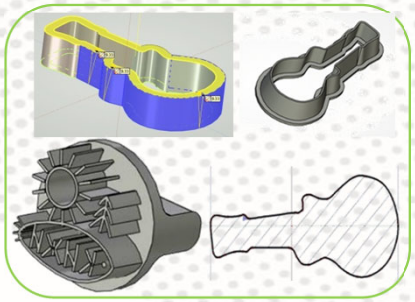


Case 2: post-processing of a plastic product surface

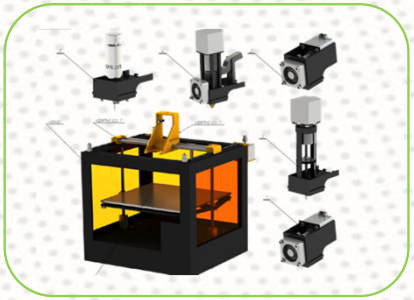


Case 3: micro-screw for 3D-printing

Case 4: vacuum former with increased moulding capacity



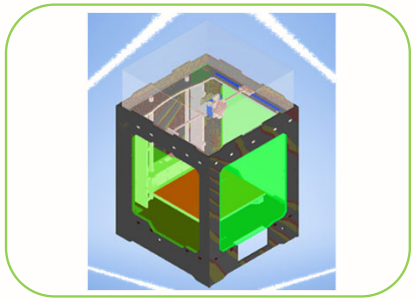
Case 5: interchangeable tool for biomaterial mould making



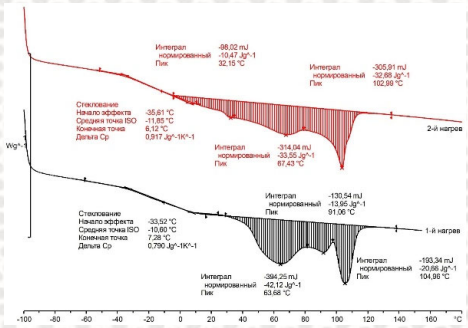
Case 6: ... much more

МОСКОВСКИЙ ПОЛИТЕХ

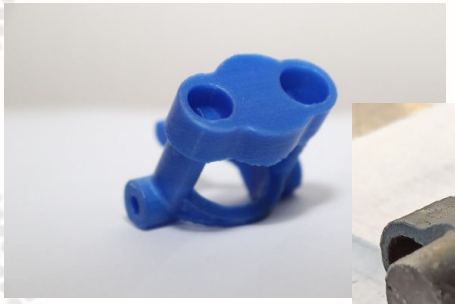
Case study projects: where is the place for research?



Case 2: 3D-printing with low temperature plastics

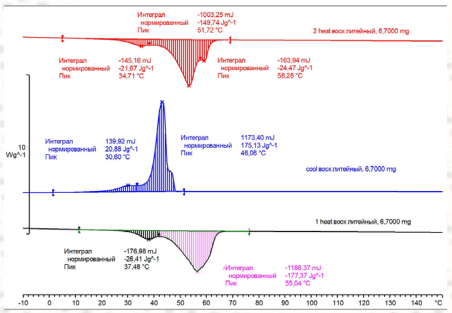


Thermal properties of material (DSC) – temperature selection for 3D-printing



Температура	rectilinear 45			concentrically		
	Нагрузка N	удлинение при разрыве %	Прочность МРа	Нагрузка N	удлинение при разрыве %	Прочность МРа
90	40,9	91,6	3,19	44,3	95,9	3,48
100	51,2	58,2	4,14	54,7	38,4	4,25
102	53,2	32,7	4,18	56,7	20,3	4,54
105	47,1	38,9	3,81	58,4	25,8	4,68
110	54,4	23,1	4,4	64,4	20,6	5,22

Mechanical properties of material



Thermal properties of material (DSC) – temperature selection for melting

Properties:

- **thermal – I**
- **mechanical**
- **thermal – II**

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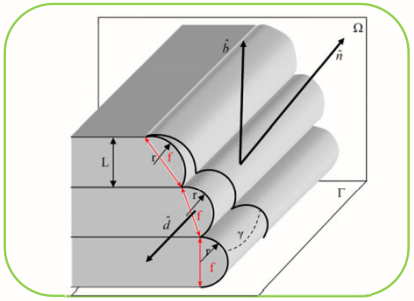
** P. Petrov, M. Bronin, B. Saprykin, M. Dolgov. 3D-Printing with Low Temperature Plastic. // Additive Technologies, No. 1 2022, pp. 16-19*

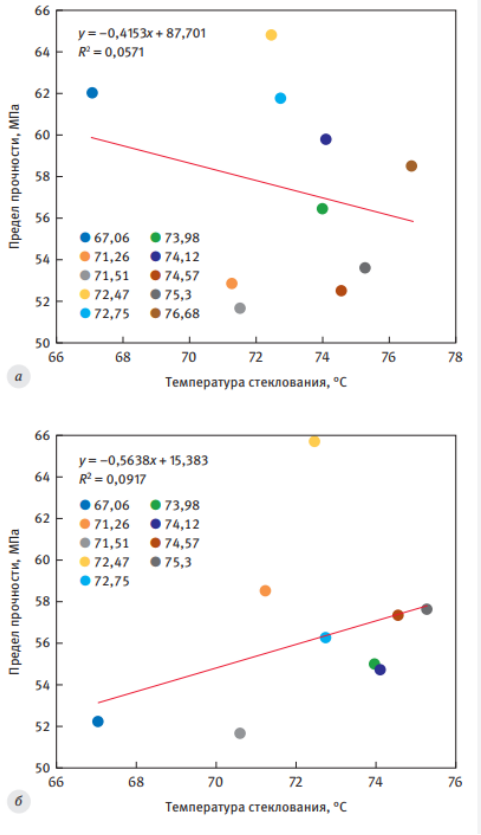
** Master's thesis by M. Bronin*

Case study projects: where is the place for research?



Case 3: post-processing of a plastic product surface

Properties:
- **thermal**
- **mechanical**
- **optical**
- **electrical**



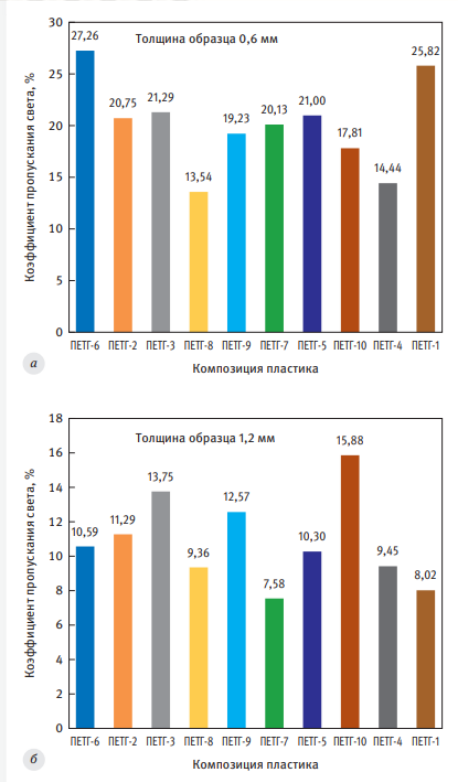


Рис. 18. Влияние состава композиции пластика на коэффициент пропускания света на длине волны 650 нм (ориентация 0°); *а* – 6 слоев; *б* – 12 слоев

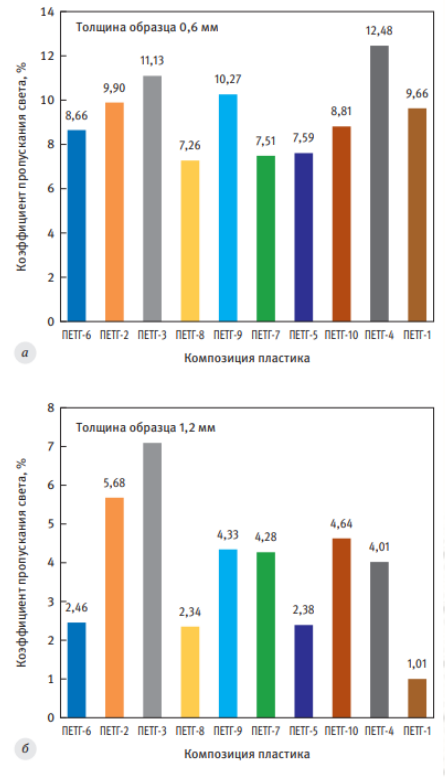


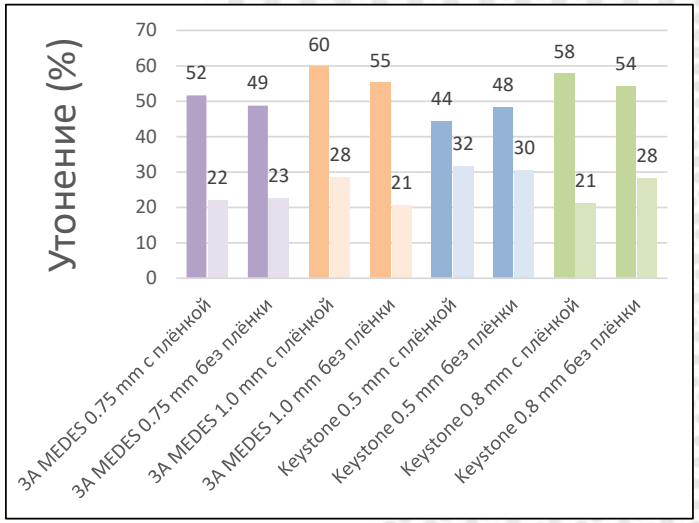
Рис. 19. Влияние состава композиции пластика на коэффициент пропускания света на длине волны 650 нм (ориентация 90°); *а* – 1,5 слоя; *б* – 3 слоя

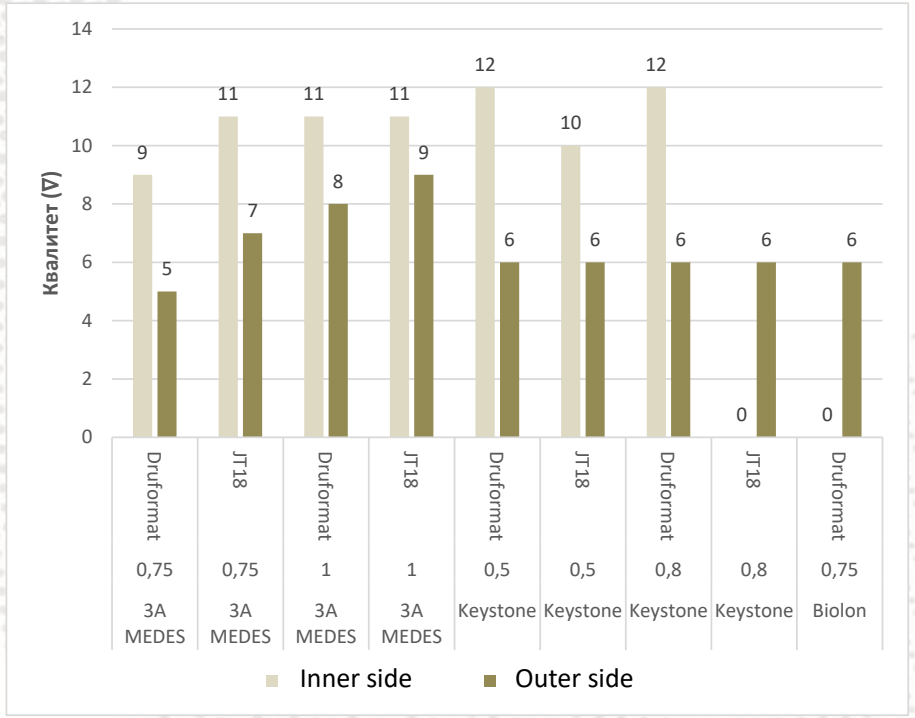
МОСКОВСКИЙ ПОЛИТЕХ

** P. Petrov, D. Agzamova, I. Chmutin, N. Shmakova, V. Pustovalov, B. Saprykin, E. Zhikhareva. Properties of PETG Plastic after FFF 3D Printing. // Stankoinstrument, No. 2 2022, pp. 58-64*
*** Bachelor's thesis by D. Agzamova, V. Pustovalov; Master's thesis by D. Agzamova*

Case study projects: where is the place for research?

Case 5: vacuum former with increased moulding capacity





Properties:

- **thermal**
- **optical**
- **geometric dimensions**
- **surface roughness**

*** Bachelor's thesis by D. Malysheva; Master's thesis by K. Orlov*

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