

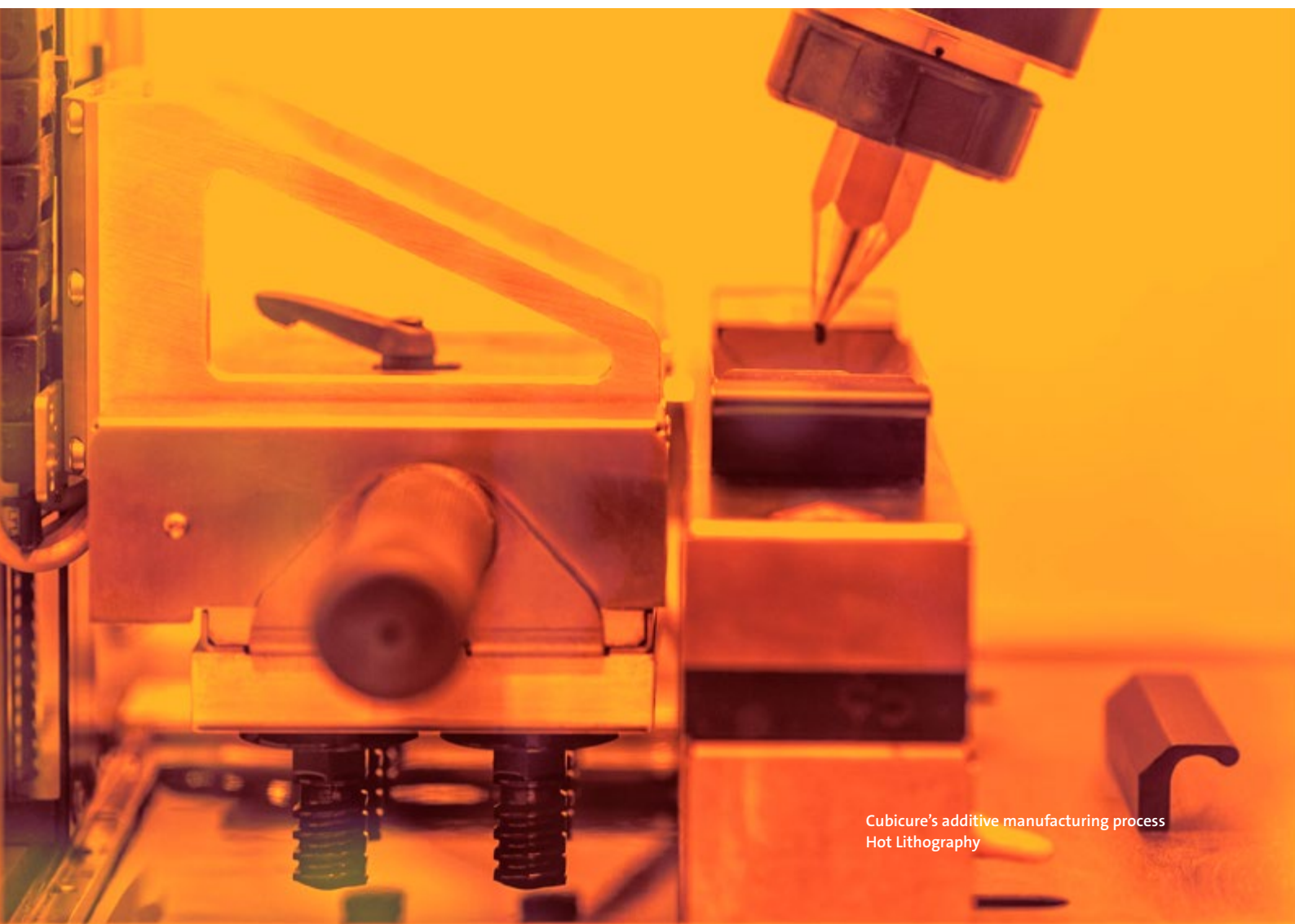


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EPO TECHNOLOGY TRANSFER CASE STUDIES | CUBICURE

Changing the 3D printing landscape

The development of a long-term technology transfer strategy allowed the Technical University of Vienna to jointly build IP in additive manufacturing with its industry partner, Ivoclar. Balancing the allocation of usage rights by application field led to the commercialisation of the research results by Ivoclar and the university's two spin-offs, Lithoz and Cubicure.



Cubicure's additive manufacturing process
Hot Lithography

From a promising material to complex AM machines

In the early 1990s, Professor Jürgen Stampfl from the Technical University of Vienna's Institute of Materials Science and Technology started researching additive manufacturing (AM). More commonly known as 3D printing, AM constructs three-dimensional objects from 3D model data. At the time, AM technologies largely produced prototypes for plastic and metal objects with specific geometrical shapes.

Stampfl soon realised that AM might offer additional potential if it were extended to ceramic materials. Up until the early 2000s, the industrial manufacturing of ceramics using 3D printing processes was carried out using raw materials from the coatings industry. These coatings were designed for other purposes and lacked the necessary requirements for massive ceramic components. Therefore, in 2002, Stampfl teamed up with Professor Liska from TU Vienna's Institute of Applied Synthetic Chemistry, a specialist in photopolymer materials, to search for suitable materials. They initiated what later became one of TU Vienna's most successful technology transfer cases.

The team started to work with state-of-the-art AM machines, which were made to process low viscosity materials. However, these systems could not effectively process the ceramic slurries, due to their high solid loading with ceramic particles and the resulting high viscosity. As a consequence, the research team and its two PhD students, Johannes Homa and Johannes Benedikt, concentrated on developing the AM machines, as well as new materials. The improved AM machines could process light-weight, hard ceramics with high melting points, thereby opening up a whole new sphere of advanced applications.

Advancing prosperous co-operation

To finance their research, the team looked for a sponsor and co-operation partner who would be interested in filing a joint research proposal supported by public grants. Ivoclar Vivadent, an international dental company based in Liechtenstein, with whom Liska had previously carried out R&D projects, was identified as a potential candidate.

TAKEAWAY

INDUSTRIAL PARTNER

Building up a network of trusted partners is essential for technology transfer at any level. The creation of technical solutions to overcome complex problems often requires an interdisciplinary approach. Application-driven R&D needs industrial sponsors to engage in joint R&D projects.

Ivoclar was eager to learn more about Liska's and Stampfl's ideas to combine photopolymers and AM technologies to produce ceramics. They proposed a research collaboration, building on the university researchers' work on an AM method for polymerisable material. Before starting the collaboration, the researchers first consulted TU Vienna's Technology Transfer Office (TTO). After assessing the technology, the TTO experts recognised the commercial potential of the researchers' background IP. They saw a strong business case and a broad range of possible applications, far beyond Ivoclar's core interest of dental applications.

As a private sponsor, Ivoclar nevertheless requested an exclusive right in their core business area to keep investing in the technology development. The challenge was therefore to design an R&D collaboration contract that would satisfy Ivoclar's interests, while allowing TU Vienna to seize other opportunities. The solution was to grant Ivoclar exclusive rights in all project outcomes for its core business area of dental applications, while TU Vienna retained all commercialisation rights for other application areas. The agreement gave TU Vienna enough control over the IP to commercially exploit the project results outside of the dental field. This allowed TU Vienna to turn research into as many applications as possible.

TAKEAWAY

CONTROL OVER COMMERCIAL EXPLOITATION

In third-party funded projects, the TTO's IP management system must secure control over the allocation of usage rights in order to increase the chances for broad commercial exploitation of academic technologies in as many applications as possible.

The devil is in the detail

“With a technology transfer, it is important not to get tempted by quick wins, sacrificing long-term benefits.”



Jürgen Stampfl
Professor at TU Vienna,
co-inventor and co-founder
of Lithoz and Cubicure
Managing Director and
Chief Science Officer (CSO)
of Cubicure

The first agreement between TU Vienna and Ivoclar related to AM and photopolymer technology research, kicking off a co-operation that is still ongoing to this day. At this initial stage, it was crucial for both parties to define the scope of Ivoclar's exclusivity for dental applications for joint research results. A lack of clarity in this respect would undermine the freedom to operate required to pursue commercialisation plans outside the dental field. TU Vienna would then reserve the right to grant licences to third parties for all other areas of application.

Ivoclar, as the private sponsor, agreed to pay all costs for this and any following R&D projects that were not covered by public grants. Therefore, all agreements between TU Vienna and Ivoclar secured not only funding for TU Vienna's R&D activities but also performance-based payments, such as turnover share and fixed milestone payments from Ivoclar in the event of patentable inventions and their commercial exploitation by Ivoclar.

The pair also agreed that Ivoclar should be provided with a share of third-party income if TU Vienna successfully secured licensing in non-dental application areas. This ensured that both parties should benefit from a commercial exploitation outside of Ivoclar's core business.

In addition to its financial contribution, Ivoclar also provided intellectual support. In fact, all 20 patent families filed to date are based on joint inventions between Ivoclar and TU Vienna. The TTO's assessment of the initial invention disclosure showed that more tangible data and further research results were needed to obtain the strongest possible patent protection. The pair then agreed to jointly develop the IP.

Although Ivoclar bears all patent-related costs, both parties jointly own the IP and decide on the patent filing strategy and the countries in which to protect the inventions, keeping each other's strategic goals in mind.

Technical breakthrough and the first spin-off

In 2011, after securing the required IP rights, Johannes Homa, CEO, Johannes Benedikt, CTO, and Prof. Jürgen Stampfl created the spin-off company Lithoz.¹ One year earlier, TU Vienna's research team had made an important technical breakthrough: they achieved the same density and strength with their 3D-printed ceramic parts as the ones manufactured using conventional subtractive production methods. The technology had reached market readiness, offering all the advantages of AM, such as cost and time reduction, and moreover a freedom-of-design approach not known before in the ceramics sphere. Certain geometrical shapes, for example lattice structures, could not previously be manufactured with this kind of material, and prototyping and production of single pieces also became much easier. This became the basis for Lithoz's future success.

Lithoz negotiated a licence agreement with TU Vienna to produce AM machines and related material for high-performance ceramics for biomedical applications, technical applications (machinery, electronics, semiconductors) and ceramic casting cores for turbines. Under the licence agreement, TU Vienna agreed not to grant any other licences for the relevant patent families to third parties. Early-stage payments can be a financial risk to deep tech start-ups before they reach the market, so TU Vienna relied only on turnover-based royalties as compensation.

“Licence agreements with your home university are the essential legal basis for any academic spin-off, and a university's TTO has to be a reliable, fast-acting and pragmatic partner facilitating the spin-off's success.”



Johannes Homa
CEO Lithoz

¹ See complementary case study about Lithoz in the EPO SME case study series at epo.org/case-studies.

LITHOZ

Today, Lithoz is a global market and technology leader in the field of AM of high-performance ceramics, currently employing over 110 people at its headquarters in Vienna and its subsidiary in the US. Lithoz continues to perform R&D to further develop its AM technology. Besides the eight patent families licensed by TU Vienna, Lithoz has also filed four of its own patent applications covering new AM machines, processes, and materials. This is also to Ivoclar's advantage, which benefits by having a business partner familiar with the technology, and which is a potential licensee for Ivoclar's dental technology.

Figure 1: Lithoz 3D-printed patient-specific medical implants



Figure 2: Lithoz entry-level 3D printer for high-performance ceramics for use in labs for the manufacture of prototypes and small-scale series production.



Creating new business opportunities

Not long after Lithoz was founded, Jürgen Stampfl and Robert Gmeiner, a PhD student, realised that the AM technology might work for other materials as well as ceramics.

“TU Vienna was relatively quick to establish a professional TTO. Once the time was ready for the next generation of 3D-printing technologies, a variety of successful start-ups was able to benefit from the professional IP management offered by the TTO”.



Robert Gmeiner
Managing Director (CEO)
and Chief Technology Officer
(CTO), Cubicure

Encouraged by Lithoz's rapid success, Stampfl and Gmeiner decided to form another spin-off company, Cubicure, in 2015. Again, they negotiated a licence agreement with TU Vienna and agreed upon provisions similar to the one with Lithoz. The agreement covered patent families that were not licensed to Lithoz and some of which were jointly developed with Ivoclar. In order to avoid competition with Lithoz and Ivoclar, the licence targeted the production of non-ceramic materials and related AM machines.

Similar to Lithoz, Cubicure aimed to strengthen its patent portfolio through a co-operation with Ivoclar. Being able to rely on a strong patent portfolio early on was important during investment rounds and strategic research projects with industrial partners.

TAKEAWAY

ACCESS TO A PATENT PORTFOLIO

A broad IP portfolio in terms of the number of patent families, claimed technologies and geographical scope provides the core basis for young spin-off-companies seeking funding and partnerships, and accessing markets.

Cubicure follows a similar business model to Lithoz. Its business model focuses on developing and selling AM machines and material. The main difference is that Cubicure deals with additive manufacturing of high-performance polymers for industrial applications, while Lithoz's focus is clearly on ceramics. Indeed, Cubicure even benefits from having Lithoz as a business partner which is familiar with the technology but is not a competitor.

CUBICURE

Cubicure develops photopolymers with thermo-mechanical properties resembling those of engineering thermoplasts. Since 2017, Cubicure has offered the specially developed and patented 3D-printing plant Caligma 200 and associated materials on the market. Cubicure aims to create AM technology for high-quality 3D prints for an industrial production environment.² Its team has grown to 35 employees with a 200 m² chemical laboratory and a 800 m² office and workshop space within the Tech Park Vienna in Austria.

Figure 3: The patented hot coating technology enables the safe use of elevated temperatures during the polymerisation process. A heated plate carries thin layers of the photosensitive material into the processing area, where a laser selectively cures it in a layer-by-layer approach.



Figure 4: Cubicure's Caligma 200, the hot lithography production unit



Role of the TTO

The TTO supports researchers with its IP management capabilities, including licensing and legal services, facilitating access to funding and industry co-operation. Even before formal IP was created, the tech transfer strategy secured financial support for TU Vienna from Ivoclar, as well as funding by public research grants while retaining rights for non-dental application areas. TU Vienna's and Ivoclar's patent management teams jointly decided which IP should be protected. Both were involved in the patenting process and in the decision about the geographic scope of patent protection, always keeping each other's strategic goals in mind. The TTO's tasks also included negotiating, drafting and supervising all contracts with Ivoclar, Lithoz and Cubicure.

TU Vienna, Lithoz and Cubicure are more than just partners in patent licence agreements. In addition, they collaborate on various R&D projects aimed at strengthening both companies' positions in maturing markets, as well as TU Vienna's know-how and research capabilities in AM.

Public funding agencies, such as the Austrian Research Promotion Agency FFG or the Vienna Business Agency, help to finance such joint R&D undertakings, leveraging the funds committed by the industry partners. This helps financing additional PhD student positions and research material, as well as to significantly scale the project beyond the initial investment.

Third-party projects can bolster a technical university's reputation. Ivoclar is an important R&D partner for TU Vienna in the area of AM. The relationship also allows the university to take a long-term perspective on research. This makes the co-operation attractive from a commercialisation, as well as from a scientific point of view. As such, it attracts talented researchers and helps to acquire additional grants from public funding agencies.

Long-term relationships between academia and industry need to be maintained by defining essential yet realistic goals, while at the same time keeping each other's fundamental business interests in mind. TU Vienna's TTO played a fundamental role in considering the latter, always trying to achieve a fair balance between sometimes conflicting interests in contract negotiations.

TAKEAWAY

MANAGING LONG-TERM RELATIONSHIPS

Long-term business relationships are crucial for successful technology transfer. Understanding, considering and defining each party's requirements helps to build the trust needed to establish and maintain such relationships.

² In 2020, StartUs Insights analysed 236 stereolithography start-ups from all over the world in a study to evaluate their industry 4.0 potential, and Cubicure was selected as having one of the four best available solutions (see www.startus-insights.com).

TECHNOLOGY TRANSFER AT TU VIENNA

A) TU Vienna's TTO

TU Vienna's Technology Transfer Office, R&TS (Research & Transfer Support), was founded in 2004, following the implementation of the Austrian University Act 2002. The act enabled universities to claim rights for employee inventions and to file and commercially exploit patents based on such inventions.

R&TS' core mission is to support TU Vienna's researchers, research groups and institutes in R&D-related activities, especially third-party funded research projects, IP protection and usage. As a publicly funded institution, R&TS strives to help researchers turn their research into useful products and services to benefit the public. Therefore, it is important to define each party's IP-related needs at each stage of a technology transfer and to consider those needs in contractual arrangements. This allows each party to secure its necessary IP position. At the same time, R&TS may also support the creation of patent applications and patents granted solely for the purpose of supporting researchers in their efforts to acquire public or private third-party funds: patents are an excellent way for a university to prove the applicability and commercial relevance of its research activities.

There is a strong interaction between local and Austrian technology transfer offices, including TU Vienna's R&TS, via the knowledge transfer centres (WTZ) launched by the Austrian Ministry of Science, Research and Economy in 2014. WTZ is a partnership between all Austrian universities and affiliated partners. Its goal is to promote interaction between TTOs and foster co-operation with other academia, industry and society in order to optimise Austria's knowledge transfer activities.

B) Patents at TU Vienna

Using patents to protect knowledge has become increasingly important for TU Vienna. Each year, TU Vienna is granted about 30-35 national and international patents, not counting patents generated in the course of contract research and filed by the university's partners. Developing a patent portfolio makes competences in its main research fields more visible. In an increasingly competitive environment,

this strengthens TU Vienna's international positioning as an excellent research institution. Securing IP also increases TU Vienna's attractiveness to its industrial partners. An extensive patent portfolio is used as a marketing tool to initiate new research collaborations. The industry increasingly gives preference to those research partners whose scientific findings are protected by patents, as this also strengthens their position vis-à-vis competitors. Additional funding is required to further develop patented technologies to make them market-ready. On the one hand, co-operation enables further development of the technology and, on the other hand, the emergence of new basic research ideas, which in turn lead to further research work and projects, eventually leading to job creation. This value chain "from basis to application" enables the newly generated knowledge to be passed on to society.

C) Patent management at R&TS

R&TS patent managers support the entire patenting process and help inventors to market their technologies. After clarifying the ownership structure, they examine the patentability and marketability of the inventions. The following criteria are also taken into account when deciding whether to claim or release an invention:

- the possibility of proving patent infringements
- the commercial value of the technology
- the presence of a prototype
- the implementation time until market readiness
- investment costs up to market readiness
- the interest of the inventor in participating in the marketing process

The decision about the territorial scope of protection depends on market research results. Despite numerous registration strategies, TU Vienna prefers the following procedure in most cases: (1) European or Austrian priority registration; (2) international (PCT) application (within 12 months after the priority application, with the EPO as search authority); (3) further national or regional patent applications (within 30/31 months after the priority application).

Patenting research is not a goal in itself but is intended to provide an incentive for potential business partners to implement these research results and thereby increase the willingness to invest in the respective technology. That's why a usage rights strategy is combined with the patenting of scientific results. In many cases, the researchers already have contacts within the industry.

After many years of work, the researchers are familiar with the companies engaged in R&D in their field and already know which technology might fit to which company. In such cases, researchers often take over the management of the usage rights and R&TS staff accompany the entire process, especially negotiations and contract drafting. In other cases, R&TS patent and licensing managers look for interested parties within industry or present the technologies concerned at fairs, conferences or similar events. Working with the inventors, they create a technology offer describing the main features of the patented technology and carry out detailed company and market research. Often, this approach requires a high level of technology readiness, and additional R&D efforts are needed before a successful deal can be concluded. Occasionally, the exploitation of the patented technologies is outsourced to specialised market facilitators, provided that their expertise and network increase its chances of success.

D) Spin-offs

About five to ten spin-offs are generated at TU Vienna each year, with figures rising slightly over the last few years. TU Vienna is open for any kind of co-operation serving both parties' requirements. In particular, it appreciates R&D collaboration, whether contract research or public-funded R&D projects, as they strive for a deeper understanding and further development of the research carried out at TU Vienna and raise questions for further basic research activities, which could lead to further spin-offs or research activities. All that could lead to further spin-offs or commercialisation activities. TU Vienna is also flexible about

handling IP with its spin-offs: it grants, restricted or unrestricted, non-exclusive or exclusive licences based on both parties' needs. In rare cases, IP might be sold or transferred. If the IP allows no other applications than the one for the spin-off's business case, the contract includes an option to acquire the IP that can be executed at a determined price. Initially, start-ups are usually not in a financial position to buy IP at an appropriate market price, but often exercise the option once they scale up. If, however, agreement on market terms for a licence or for an IP transfer cannot be reached, TU Vienna can take an equity stake in the company in addition to favourable licence terms for the spin-off.

E) Incubators

In terms of entrepreneurship support, R&TS intensively collaborates with two incubators: TU Vienna's in-house incubator innovation incubation centre (i²c) and INiTS, a limited liability company owned by TU Vienna, the University of Vienna and the Vienna Business Agency.

INiTS is Vienna's high-tech incubator. It supports academic institutions in fulfilling the targeted use and transfer of academic knowledge into society. It offers entrepreneurship training for university staff and supports research assistants in applying for the FFG Fellowship Programme³, which assists in the commercial exploitation of research results and offers participation in the SCALEup international incubation programme, where promising business models are developed with selected high-tech start-ups. Here, academic institutions are supported in technology commercialisation and the establishment of new spin-off companies. Lithoz is one of the programme's over 250 alumni.

³ The Spin-off Fellowships Programme of the Federal Ministry of Education, Science and Research (BMBWF).

Figure 5 : Technology transfer timeline

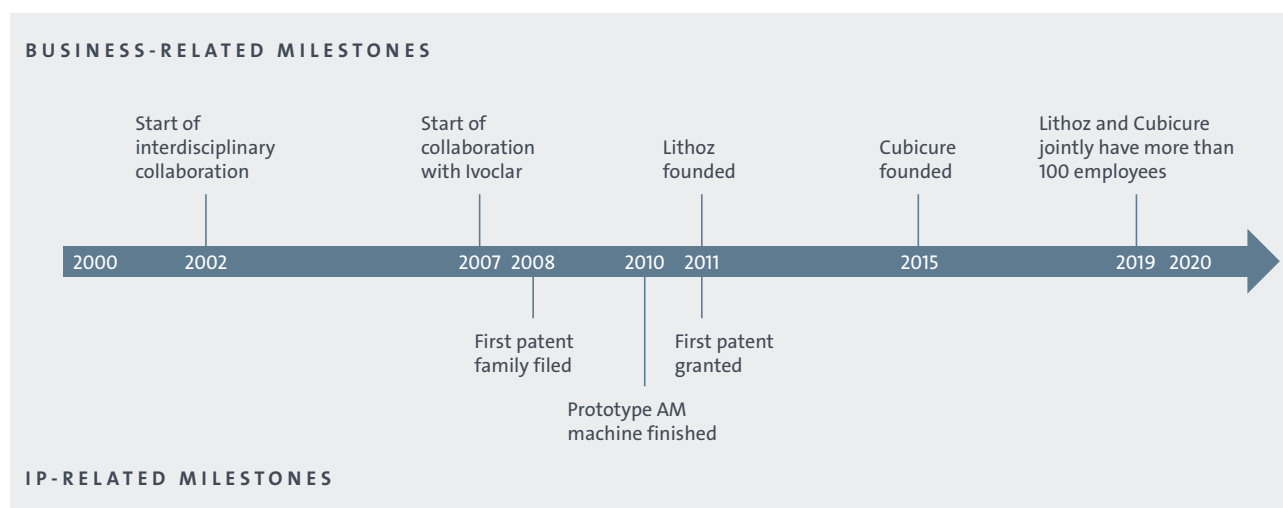


Table 1: Cubicure's patent portfolio

| Patent number | Title | Priority date | Applicant |
|-----------------------------|---|---------------|---------------------------------------|
| Owned by Cubicure | | | |
| EP3418033A1 | Method and device for lithography-based generative production of three-dimensional forms | 19. 06. 2017 | Cubicure (AT) |
| EP3632941A1 | Resin composition | 01.10.2018 | Cubicure (AT) |
| EP3284583A1 | Method and device for lithography-based generative production of three-dimensional moulds | 18.08.2016 | Cubicure (AT) |
| EP3842864A1 | Systems and methods for lithography-based additive manufacturing of three-dimensional (3D) structures | 23.12.2019 | Cubicure (AT) |
| EP3842865A1 | Systems and methods for lithography-based additive manufacturing of three-dimensional (3D) structures | 23.12.2019 | Cubicure (AT) |
| Licensed by Cubicure | | | |
| EP3023226A1 | Stereolithography device with a heating device | 19.11. 2014 | Ivoclar Vivadent (LI); TU Vienna (AT) |
| EP3091037A1 | Sulfonic acid ester as regulator in radical polymerisation reactions | 07.05.2015 | Ivoclar Vivadent (LI); TU Vienna (AT) |
| EP2875934B1 | Device for processing of photopolymerisable material for building up a moulded body in layers | 22.11.2013 | TU Vienna (AT); Ivoclar Vivadent (LI) |
| EP3071394B1 | Device for processing photopolymerisable material in order to construct a shaped body layer by layer | 22.11.2013 | TU Vienna (AT); Ivoclar Vivadent (LI) |
| EP3166569B1 | Composites with controlled network structure | 11.07.2014 | Ivoclar Vivadent (LI); TU Vienna (AT) |
| EP3396455A1 | Photocurable composition | 28.04.2017 | TU Vienna (AT) |

Some of the EP applications listed are still pending and no decision to grant has been taken. Granted patents may also undergo an opposition or appeal procedure, in accordance with the procedures laid down in the European Patent Convention, which could limit the scope of protection of the patent. All legal events are published in the European Patent Register and can be accessed via www.espacenet.com

| MAIN PLAYERS INVOLVED | SOURCE OF IP | TECH TRANSFER CATALYSTS | IP COMMERCIALISATION |
|-----------------------|---|---|---|
| | <p>Jürgen Stampfl</p> <ul style="list-style-type: none"> ➤ Professor, TU Vienna R&D project leader and co-founder of Lithoz and Cubicure ➤ sold his shares in Lithoz to invest in Cubicure as Managing Director ➤ received the Houska prize in 2013 and 2019 | <p>Technology transfer office R&TS</p> <ul style="list-style-type: none"> ➤ founded in 2004 with the implementation of the Austrian University Act 2002 ➤ supported researchers with IP management capabilities, licensing and legal services, funding ➤ negotiated financial support for the TU Vienna from an external partner, Ivoclar ➤ involved in the patenting process and in negotiating, drafting and supervising all contracts with Ivoclar, Lithoz and Cubicure | <p>Ivoclar Vivadent</p> <ul style="list-style-type: none"> ➤ an international dental company based in Liechtenstein ➤ developed IP jointly with the university, signed IP contract on research collaboration in 2007 ➤ owns exclusivity on joint research results in their core business: dental field ➤ covered all costs for joint R&D projects with TU Vienna and bares all patenting related costs ➤ owns IP jointly with TU Vienna |
| | <p>Johannes Homa, Johannes Benedikt</p> <ul style="list-style-type: none"> ➤ former PhD students and co-founders of Lithoz | | |
| | <p>Robert Gmeiner</p> <ul style="list-style-type: none"> ➤ former PhD student and founding director of Cubicure | | |
| | <p>TU Vienna</p> <ul style="list-style-type: none"> ➤ acquired more than EUR 89 million private and public third-party funds for R&D activities, including more than EUR 16 million from the EU in 2020 ➤ 30-35 national and international patents are granted for TU Vienna each year | | |
| | | | <p>Lithoz</p> <ul style="list-style-type: none"> ➤ university spin-off formed in 2011 from technology developed in collaboration with Ivoclar ➤ has an exclusive licence agreement with TU Vienna for producing AM machines and related ceramic materials for non-dental applications ➤ employs over 110 people at its headquarters in Vienna and its US subsidiary <p>Cubicure</p> <ul style="list-style-type: none"> ➤ formed in 2015 as a second university spin-off from technology developed in collaboration with Ivoclar ➤ licence agreement targeted the production of non-ceramic materials and related AM machines ➤ its technological core deals with AM of high-performance polymers for industrial applications ➤ 35 employees in Austria |

Further technology transfer case studies can be found at epo.org/case-studies