The ADDSET R&D Project led by CT opens new doors to on-demand manufacturing

- **ADDSET, an R&D project led by CT, in collaboration with the EURECAT Center and financed by ACCIÓ through its NUCLIS program, has completed its first trials successfully.**
- **After more than a year of development, ADDSET has moved closer to its objective of improving on-demand manufacturing technology by formulating a thermosetting resin capable of being used to manufacture thermoplastic injection molds.**
- **This project is another step toward on-demand manufacturing that is highly adaptable to changes in part designs, which, combined with optimization and designs adapted to 3D printing technology, could reduce the overall cost of manufacturing.**

The ADDSET Project, acronym for Application, Development and Demonstration of Thermosetting resin (ThermSET), aimed at additively manufacturing molds for the injection of thermoplastics, is a project funded by ACCIÓ within the Nuclis Internationals program. In this project CT has taken another step forward in the development of on-demand manufacturing by developing a thermosetting resin whose glass transition temperature is high enough to be used to manufacture thermoplastic injection molds. The quality of the new material has been demonstrated by using it to manufacture a mold employed in the aeronautical and automotive transportation sectors.

The project objective was achieved by applying this technology to a practical case for Airbus in the Fraunhofer IFAM research Institute in Germany, with the collaboration of EURECAT.

The project is led by CT Ingenieros, and includes the collaboration of various partners: COMPRISETEC, FRAUNHOFER IFAM, EURECAT.

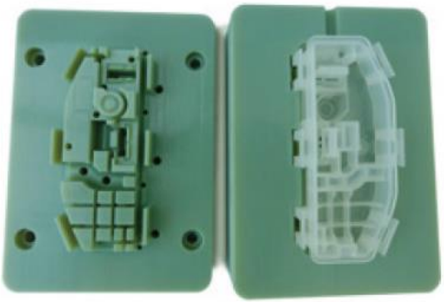

Illustration 1. Plastic injection mold built by additive manufacturing and injected part

This technology allows for rapid adaptation to changes in part designs, which, when combined with the optimization and adaptation of design for 3D printing technology, can help to reduce the overall manufacturing cost, making it a very attractive option for manufacturing molds, tooling and assembly machines and tools.

Applying 3D printing technologies to this area will clearly make the businesses that use them habitually more competitive.

Illustration 2. Metallic cavity and mold printed in 3D

The ability to manufacture a single piece or small batches can potentially lower costs related to additive manufacturing technologies by reducing the amount of raw material used, taking maximum advantage of material, and reducing manual labor, as it is an automated process. It also has other advantages, such as shorter delivery times, improved functionality and greater possibilities of personalization.

The injection process is well known for being fast, automated and flexible, with the ability to manufacture geometrically complex parts with high precision, parts that weigh from just a few grams to 100 kg.

However, from a business perspective, this process is generally only viable when manufacturing at least 10,000 units, as it is difficult for shorter series to be worthwhile.

It usually takes from 6 to 16 weeks for a mold to be manufactured and ready to use to produce parts, and sometimes they need posterior adjustments that delay the production run. These issues increase the cost of the injection mold and the opportunity cost of the product on the market.

The issue is how to take advantage of thermoplastic injection in sectors in which short runs make it unfeasible, for example, when only 100 pieces are needed or when the parts are required urgently, in just a few days.

One example of a slow-paced sector that currently cannot take advantage of thermoplastic injection is the aeronautics industry, another is the special road vehicle sector.

Because it is so important to optimize the weight of parts in the aeronautical sector, they often have complex shapes not found in other sectors. In fact, the tendency in this industry is to produce increasingly complex parts and it is shifting away from metal parts to polymers. In many such cases the parts cannot be directly printed in 3D, either due to a lack of the specific material needed to make them (there is a limited range of materials that can be used in 3D printing, set by printer manufacturers) or because of other technical factors related to the variability of the process.

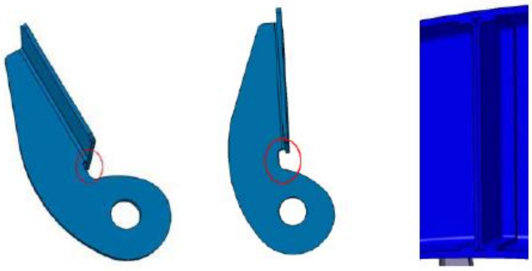

Illustration 3. Examples of aircraft parts, currently in metal, that could be manufactured in ADDSET by thermoplastic injection

The implementation of specific mold cavities is generally one of the most expensive tasks in the manufacturing process. Moreover, because it is the most technically challenging area of the mold, it is also the most time consuming part to manufacture.

Injection molds are currently being 3D printed, either for prototypes or for a limited number of units.

However, the life of the mold is quite short for various reasons, mainly due to the poor conductivity and low thermal stability of the polymers being used. Due to these limitations these molds can usually only manufacture from 1 to 50 units.

The polymers employed are those available from the machine manufacturer, including: polyethylene, polypropylene, PLA, ABS and PETG. More technical ones are being developed, such as PEEK, PPSU and PPSF, just to provide a few examples.

Based on the current state of the art the ADDSET Project set the following objectives:

- Improve thermal conductivity: the goal is to quickly achieve a uniform temperature in the part of the mold made with thermosetting resin and thereby avoiding mechanical effort due to thermal solicitations, this would considerably increase the life of the mold.
- Improve thermal stability: this would prevent deformations in the mold caused by thermal cycling, providing dimensional stability to it and to the part it is being used to manufacture, this would allow more pieces to be manufactured using the same mold.

Some of the intrinsic characteristics of the materials, resins, thermosets that ADDSET seeks to take advantage of are:

- Higher average mechanical resistance to thermoplastic resin[JBA1]
- Good resistance to distortion by temperature
- Low yield (lower deformation coefficient under the influence [JBA2]of mechanical solicitations)
- Greater tackiness, which allows printing directly on a subcomponent

From a quantitative point of view, ADDSET sought to achieve the following goals:

- Increase the life of 3D printed molds by a factor of 3 with a new thermosetting resin: based on the current limitation of a maximum of 50 injected pieces at the adequate quality;
- Reduce the costs of manufacturing injection molds by a factor of 2, employing a new resin for the cavity: based on the tooling of a steel cavity for molds;
- Reduce the delivery time of the mold by a factor of 3: based on the average delivery time of approximately 10 weeks to produce a mold using conventional technology;
- Optimize the weight of the piece using an innovative design approach (DIGIMAT), so as to cut weight by a factor of 1.4: based on pieces manufactured in aluminum with a density of 2.78 g/cm3;

- Based on the initial results of the project, a thermosetting resin has been formulated that allows technical polymers such as PA66 (polyamide) reinforced with fiberglass to be injected. After 100 injections, virtually no burrs are observed on the pieces produced and the mold has not peeled.

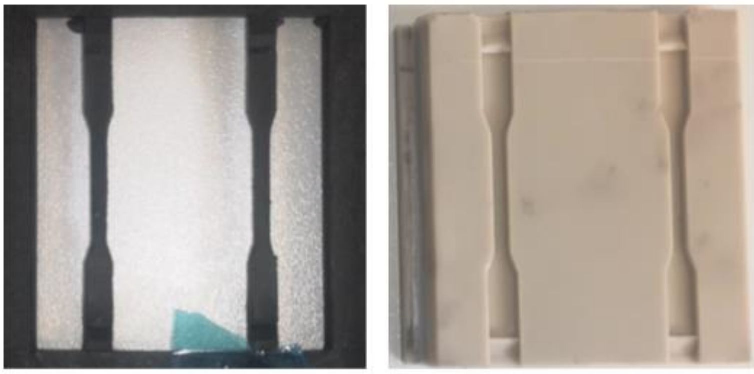

Illustration 4. Test pieces and mold after 100 injections

About CT

CT provides engineering services in the aeronautics, naval, automobile, train, energy, industrial plant, architecture and construction sectors. We cover the entire life cycle of projects, from product design engineering, manufacturing engineering to after-sales support. CT has more than 1,600 employees and a network of offices in Spain, France, Germany, Portugal, the United Kingdom, India and Brazil. CT provides engineering services for design, manufacturing, assembly and maintenance for the civil and military sectors. CT is the only Spanish supplier of product (ES2) and manufacturing (ME3S) engineering for Airbus and the preferred engineering provider in Navantia. Other relevant work includes our architecture division's participation in the La Sagrada Familia Project or the Automotive Engineering division's participation in the AVE Medina-Meca.

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