Embedding printed devices for functional and aesthetical automotive components

New automotive structures (for both interior and exterior applications) are intended to be developed, by combining printed electronics with in-mould techniques, and providing an innovative driving experience. A contribution by the Portuguese technological research centre CeNTI

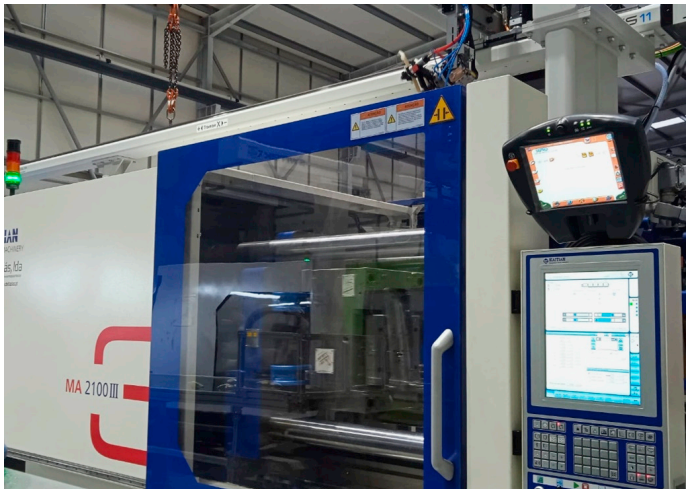
The automotive industry has been experiencing an outstanding revolution due to the development of innovative technologies for the sector, and the driving experience as known is already witnessing a crucial transformation that will continue in the forthcoming years, with the future car being designed as electric, autonomous, and connected. To accompany this change in automotive paradigm, new manufacturing methods must be designed or readjusted to incorporate novel technologies and functionalities in the vehicle body, without compromising its aesthetics and weight. By acknowledging these demands, the iDOURECA project aims to develop automotive polymeric components comprising printed devices that are fully integrated during their production by in-mould technologies, such as in-mould labelling and decoration (IML/IMD). The project results will be translated in two functional polymeric structures, with one focussing on automotive exterior, to aid in autonomous driving, and the other directed to automotive interior, for enhancement of the users' driving experience. The overall desired characteristics for these components are their lightweight and low-cost production, as well as their high differentiation and innovative impact.

To answer these challenges, a well experienced consortium was established to approach the iDOURECA project: the promoting Portuguese company, Doureca – Produtos Plásticos Lda, with broad knowledge in the production of polymeric components for automotive field, in collaboration with two Portuguese technological centers, CeNTI – Centre for Nanotechnology and Smart Materials and PIEP – Centre for Innovation in Polymer Engineering as co-promoters.

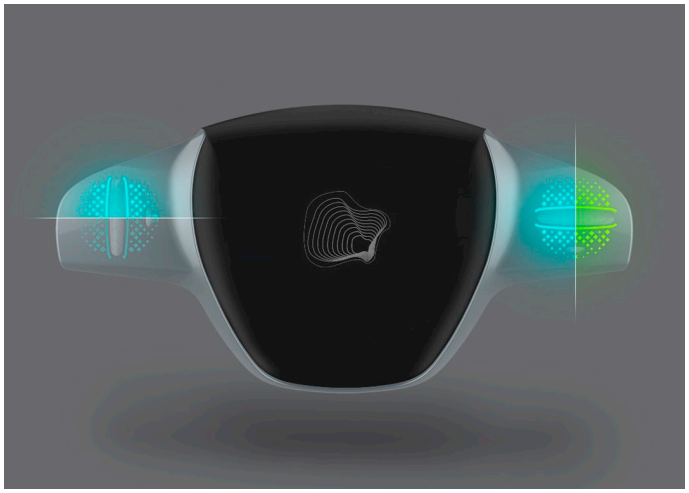
Printed electronics to enhance the autonomous experience

Significant growth in global urban transportation has already been observed with the introduction of autonomous vehicles in the market. According to the Society of Automotive Engineers (SAE) , driving automation can be described by six levels that ascend from no automation to full automation, and work has been developed in the automotive sector to provide vehicles with automated systems to monitor the driving environment. Within this type of systems, several sensing technologies, such as RADAR and LiDAR, are used to detect the presence of vehicles, objects, and pedestrians in their vicinity.

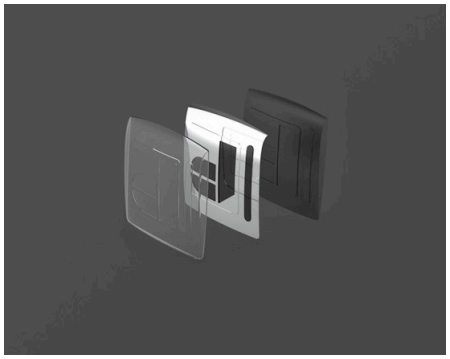
However, one of the main hurdles of autonomous driving is related to the high influence that critical environmental conditions impose on sensing systems' performance. The operation of RADAR sensors, for example, is highly affected under the presence of rain, snow and/or fog, which can therefore compromise the correct monitoring of vehicle's surroundings and hinder its autonomous operation. To overcome these difficulties, iDOURECA's project intends to develop an automotive exterior component to be placed directly in front of the RADAR sensor, helping to improve its performance



Industrial injection equipment from Doureca



Design concept of the human-machine interface for the steering wheel operated by printed capacitive sensors



Structure of the functional automotive component embedding a printed heater for an exterior application

under critical conditions, specifically in the presence of ice. To attain that, the polymeric component is provided with anti/de-icing properties by fully embedding a printed heating system in its structure, resulting in an increased capability to mitigate and/or eliminate ice layers that could otherwise accumulate on the component's surface, thus guaranteeing that the sensor's reading path is always unobstructed even under those conditions.

During the development of this component, one of the main aspects to consider is its transparency to electromagnetic radiation emitted by the RADAR. By recognising this, the overall structure must be constructed in a way that minimises the impact of its materials and the respective thicknesses on the performance of the RADAR sensor. Particularly, due to the conductive properties of the heater, its geometry is being designed to overcome that issue, while simultaneously matching the electrical requirements for its optimum operation. In the words of researcher Cristina Furtado: "The design and characterisation of printed heaters are critical aspects that have to be taken into consideration since an optimum and fully functional solution must be achieved without compromising the RADAR invisibility." Besides the heater, the final product will also comprise printed decorative features for a chromium-like appearance, reinforcing the bet of the project in printed technologies.

Human-machine interface benefits from printed sensors

Along with the automation of vehicles, their interior cabin should also be constructed in a way that promotes an improved human-machine interaction. Within this scope, the reduction or complete removal of mechanic parts is one of the main aspects to attain less complex automotive components, reducing its production time and processes. Particularly, these parts can be replaced by printed devices integrated by in-mould technologies in the automotive structure for touch control, increasing the components' robustness and improving their lifetime, whilst allowing the possibility of including aesthetical features that would otherwise be limited to implement due to mechanical parts.

By following this trend, a novel steering wheel interface is being developed under the iDOURECA project. This interface involves the integration of printed capacitive sliders and buttons in a three-dimensional polymeric piece by IML technologies, enabling the production of a fully functional product with appealing aesthetic and decorative features. In conclusion, both overall structure and sensing system are designed to be properly framed with the needs of user and machine, promoting an easy interaction with the commands of the steering wheel, whilst guaranteeing an excellent performance of the sensors. In the final product, the printed capacitive sensors will allow the interaction with lighting features also integrated into the polymeric component. "The combination of printed devices with IML/IMD technologies brings the opportunity to develop smart products with increased quality for automotive interior, improving the interaction of users and maintaining a high level of comfort," explains researcher Ana Lúcia Poças. To increase the aesthetical value of the produced component, its surface will also exhibit a textured appearance similar to a noble material.

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Image sources: CeNTI, Doureca