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Design OptiMisation for efficient electric vehicles based on a USer-centric approach

DOMUS – Deliverable Report

Deliverable 3.2 – Permanent Anti-Fogging Coating Report

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Publishable summary

Windshield and view mirrors fogging-up is a common issue met by every driver. This phenomena can act to obscure visibility of the driver, offering a safety risk if not mitigated. As a consequence to this condensation and the water surface tension, droplets form on the windshield and view mirror surfaces, scattering the light and hazardously reducing the driver's vision. To counteract fogging, the in-vehicle heating and air-conditioning systems can be used to heat the glass surface and increase ambient air temperature. The use of active systems is not an acceptable solution as it leads to an increase of the power consumption. For Battery Electric Vehicles and Hybrid-Electric vehicles, this leads to reduction in available energy to propel the vehicle, reducing the range.

Task 3.3 of the DOMUS project aimed at developing a permanent anti-fogging coating solution for windshields using a scalable, efficient and cost-effective plasma-enhanced chemical vapour deposition (PECVD) process. The selection of a PECVD process was motivated but the potential of such techniques to be operated under atmospheric-pressure conditions, which is important in the perspective of automotive applications, and at low-temperature, which are essential to ensure the integrity of the polyvinyl butyral (PVB) interlayer located between two panels of glass that form a windshield. Task 3.3 coating solution is based on a superhydrophilic thin film that comprise titanium dioxide (TiO_2) as main component. The application of a superhydrophilic coating, affording increased attractive forces with water, is foreseen to overcome the water surface tension and make the water droplets to spread as an invisible water layer.

Two approaches have been investigated at the Luxembourg Institute of Science and Technology (LIST) and characterized in collaboration with Toyota Motor Europe (TME) in the framework of Task 3.3. The first one relies on the AP-PECVD of nanostructured TiO_2@SiO_2 nanocomposite thin films. If highly transparent and anti-fogging TiO_2@SiO_2 nanocomposite thin films are readily produced from the simultaneous AP-PECVD reaction of TiO_2 and SiO_2 precursors, the films display modest mechanical properties. In spite of the investigations around the nature of the TiO_2 and SiO_2 precursors, their delivery rates and the torch configuration in the perspective to harmonize the heterogeneous and homogeneous CVD reactions did not enable the formation of mechanically robust nanocomposite coatings with durable anti-fogging properties. We suggest that the developed solution would be more appropriate to automotive parts that are not exposed to abrasion. In particular, the developed solution could be implemented on the inner side of headlamps or detectors lenses.

In a second approach of Task 3.3, the coating architecture was redesigned to better suit to the requirements for anti-fogging windshield applications. A strategy based on a single-layer thin film made of TiO_2 was selected and tuned to further enhance the mechanically properties of the anti-fogging coatings. Subsequently, the TiO_2-based single-layer thin film was doped to form coatings with durable anti-fogging properties. A TiO_2 precursor and a dopant precursor less prone to excessive gas phase reactions were demonstrated to yield dense and transparent superhydrophilic TiO_2-based thin films.

Moreover, LIST proposed to go beyond its commitment in DOMUS grant agreement and will implement the most suitable deposition conditions identified on laboratory-scale samples within Task 3.3 on windshields that will be assembled and tested at the full vehicle level at TME in the framework of WP6.