SIMULATION OF THE IMPACT OF ADVANCED LIGHT-WEIGHT MATERIALS ON ELECTROMAGNETIC SYSTEMS IN AUTOMOBILES

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ABSTRACT

The use of advanced lightweight materials such as composites and plastics may have a significant impact on the performance of electromagnetic systems in vehicles.

Antennas systems in the past have often relied on the car roof being a good conductor (ground plane) and replacing this with carbon-fibre composites or other less conductive materials may have an impact on the antenna matching, gain, efficiency, radiation pattern and coupling. The radiation pattern in the azimuth plane is important for vehicle to vehicle (V2V) communication. The presence of a sunroof or panorama glass roof may also have a significant impact on antenna performance.

Radar systems and sensors used in automotive collision avoidance systems (ACAS) may also be impacted by advanced light-weight materials. Such materials may alter the transmit/receive radiation characteristics, but also affect the radar cross-section (RCS) or signature of the vehicle.

Light-weight materials applied in the body panelling may change the response of the vehicle to electrostatic discharge (ESD). ESD can destroy sensitive electronic components, erase or alter magnetic media, or even cause fires or explosions. The electrical conductivity of light-weight materials employed in the car body design will be an important factor in the path taken by ESD currents. It is possible that currents will find a lower resistance path through cable systems and connected electronics, if the impact of light-weight materials on ESD is not considered in the design.

The use of light-weight materials installed in the floor pan of an electric vehicle (EV) may have an impact on the efficiency of inductive systems used for wireless charging. Such materials may also reduce the shielding effectiveness of high intensity magnetic fields generated by large currents associated with the charging system or the powertrain. These fields can potentially have undesired effects on electronic devices, but also on human beings inside the vehicle. The first effect is an example of electromagnetic interference (EMI) and electromagnetic simulation can be used to ensure electromagnetic compatibility (EMC), improving vehicle performance and safety. The second is an example of non-ionizing electromagnetic radiation (EMR), which is important in the field of bio-electromagnetics. Simulation can be used to predict and reduce the exposure of passengers to such fields, reducing health risks.

This paper will demonstrate the use of 3D electromagnetic field simulation to explore the impact of composite materials in a virtual automobile design based on a CATIA® model. We will employ the complete solver technology available in CST STUDIO SUITE® to simulate electromagnetic effects both accurately and efficiently over a wide frequency range; from the low frequencies associated with inductive wireless charging (100 KHz), through to the higher frequencies of mobile communications (1900 MHz), GPS (2.45 GHz), V2V (5.9 GHz) and even higher frequencies of radar systems (24 GHz). Simulations presented in this paper will include inductive magnetic field coupling, electromagnetic interference (EMI) and shielding, transient electromagnetic fields (ESD), installed antenna performance and radar cross section analysis (RCS).