Prospective Materials for Modern Railway Systems

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Abstract

The railway sector has a vital role in Portugal starting to display signs of recovery after a long period of decline. There is a growing demand for freight and passenger railway transportation as a competitive alternative to air and road transportation. Additionally, railway transportation has in comparison the lowest CO_2 footprint per passenger/ton of goods transported. The railway sector is essential as part of a global effort to meet the Green Deal goals by 2050. In this regard, challenges must be overcome. There's a need for rolling stock with lighter structures that is more comfortable for the passengers, higher speed enabling railways allowing higher speeds, heavier loads, and traffic allowance, while having a low noise emission and assuring system safety and security. Materials Science and Engineering holds an important position on the innovation for a modern railway transportation system. In this study we review some of the most relevant materials development with the most relevance for a modern railway transportation system.

High strength aluminium alloys frames, carbon fibre reinforced polymers (CFRP) panels, metallic foams, and metal-matrix composites are under development for a continuous weight decrease in car bodies [1] while ensuring strength and wear resistance. Silicon carbide semiconductors for power electronics in traction systems for their higher efficiency, operating temperature, and longer lifetime. New engineered steels for rails such as fine pearlitic or micro alloyed steels [2] for improved wear resistance while keeping toughness. Polymer matrix composites (epoxy and phenolic, reinforced with aramid, glass, and carbon) are also being developed to furnish and equip coach interiors for improved versatility and traveling comfort for passengers. Unconventional materials such as cork are promising candidates to reduce vibrations on railway infrastructure and reduce noise generated by vehicles. Additionally, smart materials that can harvest energy from the vibration generated by the vehicle have a great potential for use in railway infrastructure. In many cases there is a need to develop processes to join these materials and/or change the manufacturing approach. Additive manufacturing is an emerging approach, particularly interesting for obsolescence management, due to the ability to produce small series of parts/components at a reduced cost [3]. These new materials and manufacturing approaches are required to meet very tight specification/regulation to ensure safety, sustainability, and interoperability of railway towards a Single European Railway Area (SERA).

References

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