自主可控航空热塑模压复材典型设备构建

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摘要：C919 大型客机商业首飞成功使国人为之沸腾，大飞机关键材料也受到人们的关注。得益于轻质高强等优点，碳纤维增强聚苯硫醚（CF/PPS）、碳纤维增强聚醚醚酮（CF/PEEK）等高性能热塑性复合材料在国产大型客机上具有广阔应用前景。2012 年起，东华大学与中国商飞就热塑性复合材料国产化进行了卓有成效的合作，基于高温热压机设备持续攻坚，成功研制出先进热塑性复合材料零部件快速制造系统，填补国内空白，解决了航空热塑性复合材料成型效率低、成本高等问题。相关成果已进入中国商飞产业化验证通道，科技成果转化达 800 万元，并获得第三届“海聚英才”全球创新创业大赛十八强等多个奖项及地方引导性资金数千万元。

关键词： 热塑性复合材料；快速成型系统；冲压成型；感应焊接；热压机

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Typical Equipment Construction for Autonomous and Controllable Aerospace Thermoplastic Moulding Composites

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Abstract: The success of the commercial maiden flight of the C919 large airliner had caused great excitement in China, and the materials used in the large aircraft had also garnered significant interest. Thanks to the advantages of light weight and high strength, high-performance thermoplastic composites such as carbon fiber reinforced polyphenylene sulfide (CF/PPS) and carbon fiber reinforced polyether ether ketone (CF/PEEK) have a broad application prospect on domestic large passenger aircraft. In 2012, Donghua University and COMAC collaborated on the localization of thermoplastic composites. A rapid manufacturing system for advanced thermoplastic composite parts, which filled the gaps in the domestic market was created. The system was based on high-temperature hot-press equipment and successfully solved the issue of low molding efficiency and high cost of aerospace thermoplastic composite materials. The relevant accomplishments have undergone industrialization verification by COMAC and the transfer of scientific and technological achievements had reached RMB 8 million. It also had received several recognitions including the Shanghai "Sea Gathering Talents" Top 18 awards and tens of millions of RMB of local guiding funds.

Keywords: thermoplastic composites; rapid manufacturing system; stamp forming; induction welding; Hot pressing machine

1 先进热塑性复合材料的发展及应用

1.1 航空高性能复合材料及其国产化趋势

2023 年 5 月 28 日，国产大飞机 C919 完成商业首飞，国人振奋。在诸多报道及科普介绍中，C919 的碳纤维复合材料使用率被反复提及。复合材料(composite material)指的是两种或者两种以上物理和化学性质不同的物质组合而成的一种多相固体材料，综合了纤维、树脂、橡胶、金属和陶瓷等各种组分的优点，是轻质、高强、可设计强的先进材料[1]。以碳纤维复合材料为例，其比强度可达到钢的 14 倍，是铝的 10 倍，比模量则超过钢和铝的 3 倍。实践证明，利用碳纤维复合材料替代传统铝合金材料制造飞机结构件可使机身减重 20%~40%，以一架商用飞机 20 年的服役周期及 200 万公里的飞行里程计算，每减重 10%，就能够引起可观的节能减排效果。因此，复合材料使用比例已成为衡量新一代民用飞机先进性的关键指