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NONDESTRUCTIVE TESTING IN SPACE ENVIRONMENTS: A CRITICAL ELEMENT FOR THE FUTURE SUSTAINABILITY OF AEROSPACE DEVELOPMENT

Abstract

Space travel has always been a fascinating endeavor for humanity, with dreams of exploring distant planets and celestial bodies. As we seek to expand our presence beyond our planet, it is critical to ensure that space travel remains sustainable and safe for both astronauts and spacecraft. As we strive to make space travel more sustainable, aerospace nondestructive testing (NDT) is emerging as a critical analysis technique to achieve this goal. Aerospace NDT plays a role in making space travel sustainable by increasing safety, reducing costs, and improving overall mission efficiency. Its ability to detect flaws and defects in critical components ensures that space missions are conducted with the utmost precision and reliability, reducing the likelihood of catastrophic failures. However, NDT, like any other activity in space, must contend with the unique characteristics of the space environment. The main characteristics of the space environment that make it unique are: weightlessness, vacuum, radiation, and the composition of the residual atmosphere. All of these factors must be considered when selecting a terrestrial NDT technique for use in the space environment. As technology continues to advance, NDT in space applications will undoubtedly play an even more important role in shaping the future of sustainable space exploration. This paper examines the current state of NDT in the space environment. It begins with a review of existing research, focusing on the fundamentals, functionalities, and key challenges of adapting terrestrial NDT methods for use in space. The paper then highlights the potential of NDT systems powered by artificial intelligence (AI), machine learning (ML), virtual reality (VR), and the Internet of Things (IoT). It also examines the technical hurdles that currently impede the implementation of this technology in space applications. In addition, the paper presents a case study of welding in space to illustrate the future possibilities of innovative NDT systems incorporating AI, ML, VR, and IoT. Finally, the paper concludes by outlining potential avenues for future research and development to advance NDT innovation and applications in space.