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Abstract

Innovative Aeronautical Structural Health Monitoring Ultrasonic Sensor: From Autonomy to High Sensibility †

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Since aeronautical structures tend to be more and more sophisticated today, it becomes necessary to develop Non Destructive Testing techniques for the monitoring of last generation aircraft. This concept also called Structural Health Monitoring has as main objective to detect and locate damages occurring within the aircraft structure during its flight. To ensure a good efficiency of this SHM system, a sensor network covering all the monitored areas has to be deployed which induces at the same time numerous difficulties due to connection and wiring aspects. Consequently wireless communications as well as energy autonomy capabilities are required in order to satisfy the future aeronautical certification steps for SHM systems. In this paper, the aim is to control aeronautical composite structures on production line since composite materials that are currently employed at an intensive rate for aircraft primary structures are extremely vulnerable to impact damages due to tool drops for example. To be able to detect and locate such an event on the full composite structure (wingbox for example), a piezoelectric SHM wireless and autonomous sensor network has been developed. Therefore, the feasibility of an innovative technique based on a piezoelectric harvesting device to obtain a self-powered SHM system is presented. More precisely, the SHM system aims to have a double functionality: it will carry out classical SHM tasks using piezoelectric transducers bonded onto the aircraft structure and will also be fully autonomous since the same transducers will be used to convert the mechanical vibrations of the structure into electrical power. As natural vibrations are not available during the production process, the energetic autonomy of the system is provided thanks to a Lamb waves emitter strategically located in the middle of the sensor array. Using this new harvesting energy solution, it is shown that this system is able to harvest 7.4 milli watts for a 100 milli watts mechanical power applied to the structure. This electrical power can be used both by the electronic detector and the WIFI transmitter for the detection of impacts of less than 0.1 Joule. Finally, numerous ways of application such asnuclear industry are proposed in the paper.