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Editorial

Microwaves Non-Destructive Evaluation (NDE) of Composites

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Editorial

Composite materials are being used extensively in industry. They usually offer enhanced durability and strength. Meanwhile, they provide significant resistance to corrosion and moisture with good stability at high pressure. On the other hand, composite materials, like fiberglass, are considerably lightweight and strong; they are being applied in the fabrication of aircrafts as they are strong enough to handle pressure at high altitude. However, fabrication of composite materials is very essential. The presence of any kind of imperfection in the fabrication process can highly reduce the strength and durability of the composite structure. The detection of void, bubble, crack, and delamination in composite structure with various layers is difficult and challenged the NDE community for many years. Many non-destructive evaluation tests are introduced and being used for composite materials. These tests employ the unique properties of electromagnetic wave to transfer the information.

The most important thing regarding NDEs is they are cost effective and they don't damage the composite material [1,2]. Microwave and millimetre waves can penetrate most kind of composite materials [3] and provide a variety of information regarding the defects or electromagnetic properties of a material. The presence of crack in fibre composite is highly occurred when a structure expose to a harsh environment such as high vibration that exceed the allowable designed limited or high temperature [4]; all these can lead to crack initiation and then crack propagation which may cause structural failure. There are plenty of manufacturing defects that happen during the fabrication process [5]. Many of these damages are hidden inside the composite and cannot be inspected visually [6-8]. Therefore, monitoring these flaws online is highly appreciated in terms of industry to avoid any interruption of the production line and/or delaying for most needed product in a short time.

Many non-destructive testings are assigned to inspect the crack or voids in materials and composites such as acoustic emission technique, ultrasonic test, infrared thermography, microwave testing technique [9]. In vibration and strain-based technique, the size of the sensors or poor resolution of the obtained results may lead to unreliable detection [10-12]. Microwave testing method is a measurement technique for such voids by analyzing the reflected signal or the transmission wave. The effect of react between the woven fabric and the microwave was studied in simple manner to ensure the behaviour of scattering parameters when a defect occurs in a structure. Material properties is the key role for controlling the intensive of the electromagnetic wave reflected or transmitted from the tested structure. Hung et al. [13] selected two different types of glass fibre laminated structure (E-glass and S-glass) to monitor the in-plane shear stress by using acoustic emission associated with thermography method. They used this method to compare the composite structure behaviour when damage initiates under shear loading. In another study, Karabutov et al. [14] utilized same concept for damage localization which is 3D scanning technology. However, this method is limited only to surface as it cannot scan the internal structure unless make a fracture to the tested object. Impedance tomography is also another method which can detect surface micro crack by introducing a piezoelectric to the surface of the object [11,15,16].

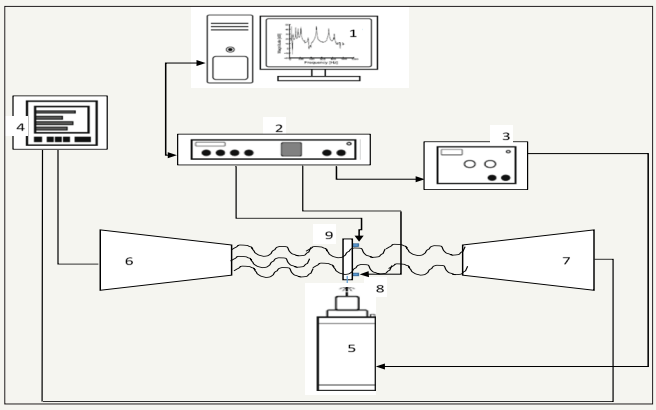

Figure 1: Proposed experimental setup.

In contrast to above mentioned techniques, the microwave thermography method is able to detect the depth of defect in the material. Microwaves can penetrate inside the material and therefore can recognize any kind discontinuity and material changing [5,8]. We propose new NDE system consist of Vertical

network analyzer as shown in Figure 1, assume able to detect various types of damage in the glass/epoxy composite structure using microwaves band. Through exploring the changes in transmitted, reflected and absorbed microwaves. Whereby, thickness of composite structure as well and effect of thickness on the received signal can be investigated.

References

1. Arumugam V, Kumar CS, Santulli C, Sarasini F, Stanley AJ (2011) A global method for the identification of failure modes in fiberglass using acoustic emission. Journal of Testing and Evaluation 39(5): 955-966.
2. Bayraktar E, Antolovich SD, Bathias C (2008) New developments in non-destructive controls of the composite materials and applications in manufacturing engineering. Journal of Materials Processing Technology 206(1-3): 30-44.
3. Bossi RH, Giurgiutiu V (2015) 15-Nondestructive testing of damage in aerospace composites. In: Irving PE, Soutis C (Eds.), Polymer composites in the aerospace industry Woodhead Publishing, UK, pp.413-448.
4. Bull DJ, Spearing SM, Sinclair I, Helfen L (2013) Three-dimensional assessment of low velocity impact damage in particle toughened composite laminates using micro-focus X-ray computed tomography and synchrotron radiation laminography. Composites Part A: Applied Science and Manufacturing 52: 62-69.
5. Burkle WS, Lemle LP (1993) The effect of order-of-film placement in composite film radiography. Materials Evaluation 51(3): 327-329.
6. Castaings M, Hosten B (2008) Ultrasonic guided waves for health monitoring of high-pressure composite tanks. NDT & E International 41(8): 648-655.
7. El-Sabbagh A, Steuernagel L, Ziegmann G (2013) Characterisation of flax polypropylene composites using ultrasonic longitudinal sound wave technique. Composites Part B: Engineering 45(1): 1164-1172.
8. Fotsing ER, Ross A, Ruiz E (2014) Characterization of surface defects on composite sandwich materials based on deflectrometry. NDT & E International 62: 29-39.
9. Garney G (2006) Defects found through non-destructive testing methods of fiber reinforced polymeric composites. California State University, Fullerton, Ann Arbor, USA.
10. Genovés V, Gosálbez J, Miralles R, Bonilla M, Payá J (2015) Ultrasonic characterization of GRC with high percentage of fly ash substitution. Ultrasonics 60: 88-95.
11. Ghadermazi K, Khozeimeh MA, Taheri-Behrooz F, Safizadeh MS (2015) Delamination detection in glass–epoxy composites using step-phase thermography (SPT). Infrared Physics & Technology 72: 204-209.
12. Giurgiutiu V (2016) Damage and failure of aerospace composites. In: Giurgiutiu V (Ed.), Structural health monitoring of aerospace composites Academic Press, Oxford, USA, pp.125-175
13. Hufenbach WB, Thieme R, Tyczynski T (2011) Damage monitoring in pressure vessels and pipelines based on wireless sensor networks. Procedia Engineering 10: 340-345.
14. Hung YY, Yang LX, Huang YH (2013) 5-Non-destructive evaluation (NDE) of composites: digital shearography. In: Karbhari VM (Ed.), Non-Destructive evaluation (NDE) of polymer matrix composites Woodhead Publishing, UK, pp. 84-115.
15. Karabutov AA, Podymova NB (2014) Quantitative analysis of the influence of voids and delaminations on acoustic attenuation in CFRP composites by the laser-ultrasonic spectroscopy method. Composites Part B: Engineering 56: 238-244.
16. Katunin A, Danczak M, Kostka P (2015) Automated identification and classification of internal defects in composite structures using computed tomography and 3D wavelet analysis. Archives of Civil and Mechanical Engineering 15(2): 436-448.

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