

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 mea-

surement 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].

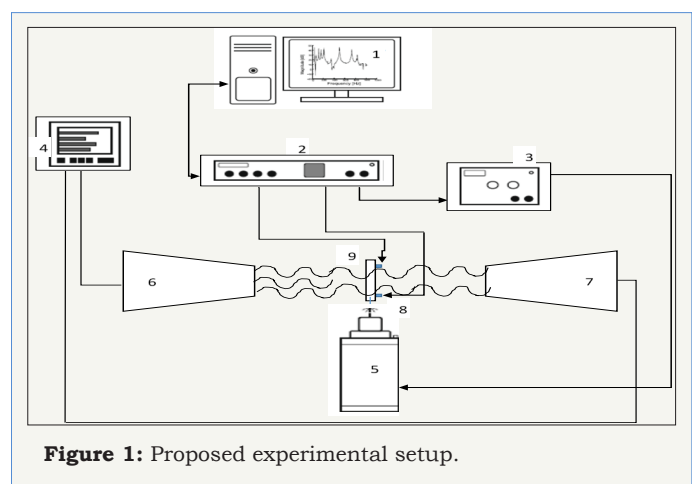


Figure 1: Proposed experimental setup.

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.

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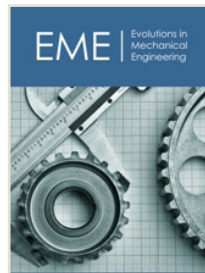
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