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## **NDT of Bonded Composite Patches on Aluminum Beams Using Integrated Ultrasonic Transducers**

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### **Abstract:**

In last three decades bonded repair technology has become a cost-effective means of repairing cracks in metallic aircraft structures. There exist several NDT techniques to evaluate these bonded repairs while the aircraft stays in the hanger and bonded repair regions are accessible. The objective of this investigation is to present a potential structure health monitoring technology using miniature and light weight integrated (IUT) and flexible ultrasonic transducers (FUTs) directly mounted onto the structure for the detection of patch disbond and its disbond growth. Four specimens consisting of double sided six plies graphite/epoxy (Gr/Ep) bonded onto a 6.35mm thick, 50.8mm wide and 406.4mm long aluminum (Al) plate are made. Artificial disbonds using Teflon inserts of 0.05 mm thick, 25.4mm long and four different widths; namely 0mm, 12.7mm, 25.4mm and 50.8 mm which correspond to 0%, 25%, 50% and 100% across the width of the Al plate, respectively, were introduced to the interface between tapered Gr/Ep composite regions and Al plates.

IUTs are deposited directly coated onto or FUTs attached to the two end edges and the edges at the two sides of the artificially implanted disbond regions of the Al plate for each specimen. They are also made at the top surface of the Gr/Ep composite over the disbond region. These IUTs and FUTs are fabricated by the sol-gel sprayed technology and have a piezoelectric film thickness ranging from 40 $\mu$ m to 100 $\mu$ m. The substrates of FUTs are a 50 $\mu$ m thick polyimide or a 75 $\mu$ m thick stainless steel membrane. They can be operated in pulse/echo or transmission modes. The center operation frequency of these IUTs and FUTs range from 2 to 15MHz. Experimental results show that these IUTs and FUTs can detect the presence of disbond which are confirmed by ultrasonic c-scans. The optimization of the size and configuration of the IUTs or FUTs for the monitoring of the growth of disbonds will be presented. The tradeoffs between the IUT and FUT approaches will also be discussed.