A New kHz Rate Laser-Ultrasound Scanner for Ply-by-Ply Imaging of Defects, Pores and Inconsistencies in Composite Structures

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Among NDT methods, only US and X-ray tomography can precisely locate three-dimensional defects regardless of composite type. X-ray systems, however, are very expensive, time-consuming and cumbersome. In addition, the chamber limits the size of the sample to several centimeters and makes it completely unsuitable for field applications. Conventional US pulse-echo techniques usually require couplants or full sample immersion for optimal energy transfer, which can affect overall scan speed and limit the applications where they can be used.

Laser-ultrasound (LU) has many advantages over conventional US. First, laser-generated US transients are ultra-wideband, providing at least 3 times better resolution compared to conventional US transducers with the same characteristic frequency [1]. Second, the system is fundamentally non-contact and removes all issues related to US coupling. Its typical disadvantages are low sensitivity, instability, low pulse repetition frequency and high cost. We have recently overcome these limitations with a new kHz rate fiber-optic LU scanner [1-4]. Here we show that the scanner can provide nearly X-ray quality 3D images (see Fig.1) and locate almost all imperfections in composites: visualize pores (Fig.1a) [5] and wrinkles, evaluate heat damage [6] and locate impact damage with a sub-ply spatial resolution (Fig.1b).

![Figure 1](image_url)

**Figure 1.** LU C-scans at two different depths of an impacted CFRP composite sample (a), (b) versus X-ray tomograms at the same depths (c), (d). Both pores in the structure and the main damage are clearly seen.

**References:**