**Application Note**

# Microwave System for the production-oriented Non-Destructive Testing of Leaf Springs made from glass fiber reinforced Plastic

FI Test- und Messtechnik GmbH

The company IFC Composite GmbH fabricates more than 1000 glass fiber reinforced leaf springs per day for the minivans Mercedes Sprinter and Volkswagen Crafter. Besides of destructive testing there is a need for non-destructive testing for production surveillance. The approximate size of the leaf springs is 1400 mm x 70mm x 30 mm. Unidirectional glasfiber prepregs are used. The complete volume of the leaf spring is to be tested for inhomogeneities.

Here the prototype of a test system for this purpose is described, see figure 1.

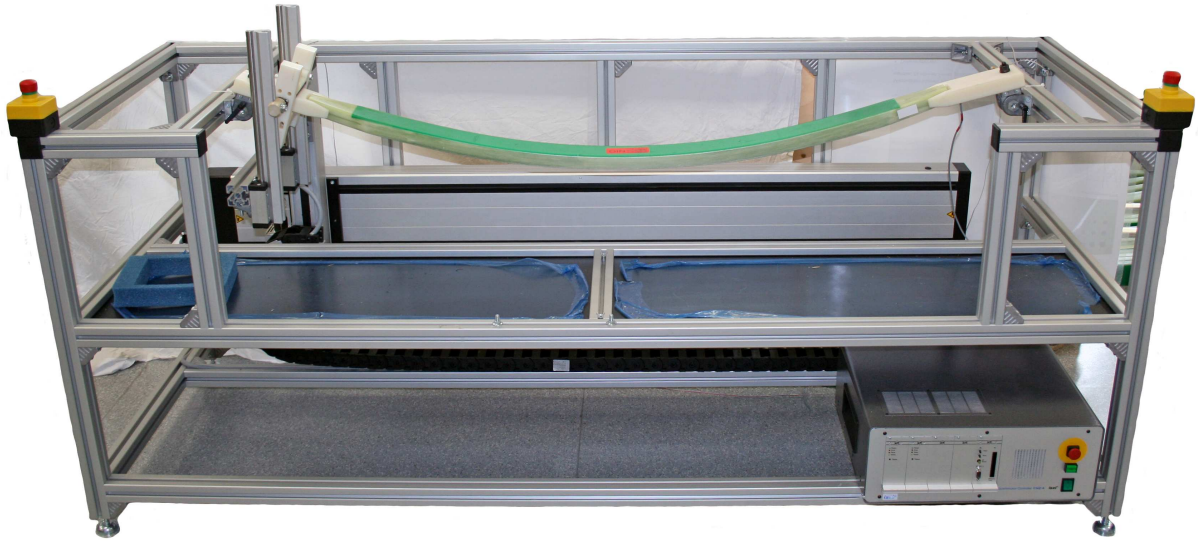
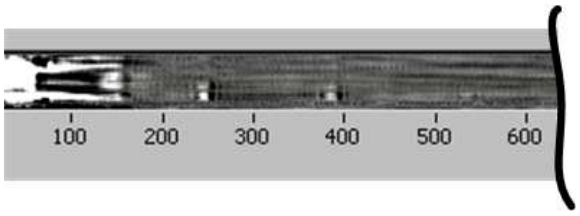


Figure 1: Photograph of the Microwave-Based NDT System for GFRP Leaf Springs.

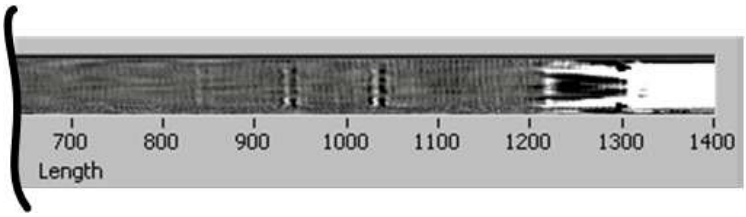
A microwave-based test procedure was chosen because traditional test procedures fail (ultrasonic testing) or are too expensive (X-ray, radiography). For microwaves the leaf spring is almost transparent; using microwave procedures local variations of the dielectric constant become visible as it is well-known from refractive index variations in optics. A frequency of 24 GHz was chosen which is allowed for industrial purposes (ISM frequency band). Furthermore this frequency is high enough for a moderate spacial resolution. The system uses a transmission procedure. The transmitter side consists of a linear array of 30 microwave channels, each with one antenna. Opposite there is a linear receiver array, also with 30 channels and receiving antennas. These arrays are oriented across the leaf spring, i.e. they extend over about 70 mm. When scanning, the microwave modul is moved along the leaf spring over a length of about 1400 mm. The scan time is about 40 seconds for a leaf spring, the following time for data processing needs about 20 seconds. Therefore the complete testing time for one leaf spring is about 60 seconds.

Figure 2 shows C-scans of leaf springs with artificial defects.



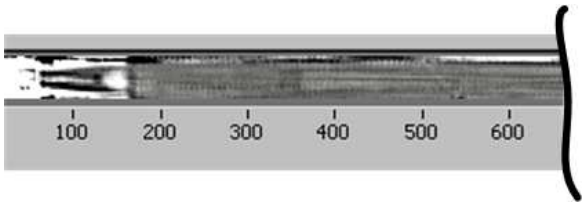

a)

Ø in mm: 3.0 2.0 1.0



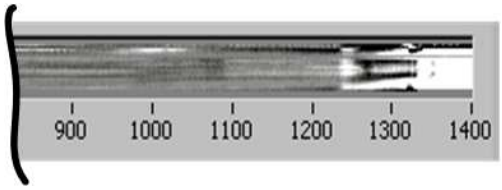

b)

Width/Depth in mm: 1.5/0.5 1.5/1.0 3.0/1.5




c)

Oblique metal filament, Ø = 0.25 mm




d)

Plastic foil 0.6 mm x 30 mm x 40 mm

Figure 2: Microwave Scans of Leaf Springs with Artificial Defects. a) Tranvsers Bore Holes b) Grooves. c) Metal Filament. d) Plastic Foil

Figure 2a shows the C-scan of a leaf spring with transversal bore holes on half height, i.e. 15 mm from lower side and top side. They are recognizable down to diameters of 1 mm.
Figure 2b shows indications of grooves which extend over the whole width of the leaf spring. They are recognizable down to 0.5 mm depth.
Figure 2c shows the C-scan of a leaf spring with an oblique metal filament of 0.25 mm diameter at the bottom, i.e. at the receiver side of the microwave modul.
Figure 2d shows the indication of a plastic foil of 0.6 mm thickness. All these artificial defects are clearly recognizable.
This application note shows an example for the use of microwave-based non-destructive testing in a production line. We would like to answer your questions regarding avaible microwave-based measurement and test equipment which can also be made customer-specific and application-specific as well as regarding further use of microwave-based non-destructive testing.

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