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Non-destructive characterization and testing of composite materials by using mechanical resonance of defects

Planar sub-surface defects are characteristic modes of failure that are induced by impacts, fatigue stresses, deviations in production process in a wide class of materials and components, including rolled sheet metals, fibre-reinforced concrete and plastics, and additive manufacturing in 3D printing solutions. To detect these defects, various classical methods of non-destructive testing (NDT) of materials were developed and applied: optical shearography, eddy current, multiple versions of thermography, and ultrasonic techniques. A novel NDT methodology proposed makes use of mechanical resonance of the defect areas. It is based on the effect of local defect resonance (LDR) which develops if the defect is activated by mechanical excitation whose frequency matches to its natural vibration frequency. The latter is based on the fact that inclusion of a defect leads to a local decrease of rigidity for a certain mass of the material that manifests in a particular characteristic frequency of the defect. Under the frequency match condition, the input energy is delivered and trapped selectively in the defect area that increases dramatically its vibration amplitude. The LDR approach thus enhances substantially the sensitivity and efficiency of the classical NDT techniques based on mechanical activation of defects. Besides, the locality of the resonance enables to visualize the defect area and to quantify its size and shape. The case studies to be considered include resonant imaging of various defects in composite materials via laser vibrometry, thermosonics and nonlinear techniques.

Recent Publications

1. Solodov I, Bai J, Bekgulyan S and Busse G (2011) A local defect resonance to enhance acoustic wave-defect interaction in ultrasonic nondestructive testing. Applied Physics Letters. 99:211911.
2. Solodov I, Bai J and Busse G (2013) Resonant ultrasonic spectroscopy of defects: case study of flat-bottomed holes. Journal of Applied Physics. 113:223512.

Biography

Igor Solodov is Guest Professor at Institute of Plastics Technology. His research mainly focuses on Ultrasonic & Nonlinear Mechanics.

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