INSPECTION OF WELDS WITH IMPULSE ACOUSTIC MICROSCOPY

Yulia PETRONYUK [1], Vadim LEVIN [2], Egor MOROKOV [2]
[1] Russian Academy of Sciences Scientific and Techological Center of Unique Instrumentation, Moscow, Russia
[2] Russian Academy of Sciences Emanuel Institute of Biochemical Physics, Moscow, Russia
jps7@mail.ru;

Abstract

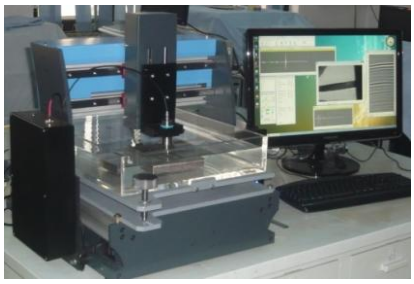
High-frequency ultrasound is an effective instrument for studying fine microstructure in the bulk of non-transparent object. One of its prospective applications is NDE of weld zones that join metallic sheets or layers by diverse kind of welding. Non-destructive inspections performed with impulse acoustic microscopes. Reflection of short probe pulses of focused ultrasound makes it possible to recover structure of welding with micron lateral and depth resolution (60-120 μm). Impulse acoustic microscopy provides detection and visualization of adhesion loss areas, both extensive and diffusive ones, in the welding zone. It has been shown the method is capable to find closed cracks and detachments areas of partial (kissing) contact, failure in contact welding.

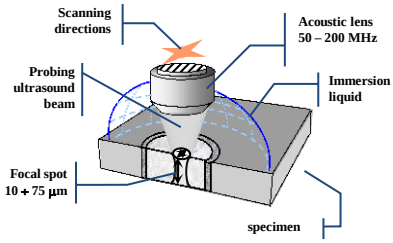
INSPECTION OF WELDS WITH IMPULSE ACOUSTIC MICROSCOPY

Yulia PETRONYUK [1], Vadim LEVIN [2], Egor MOROKOV [2]
[1] Russian Academy of Sciences Scientific and Techological Center of Unique Instrumentation, Moscow, Russia
[2] Russian Academy of Sciences Emanuel Institute of Biochemical Physics, Moscow, Russia

Abstract
High-frequency ultrasound is an effective instrument for studying fine microstructure in the bulk of non-transparent object. One of its prospective applications is NDE of weld zones that join metallic sheets or layers by diverse kind of welding. Non-destructive inspections performed with impulse acoustic microscopes. Reflection of short probe pulses of focused ultrasound makes it possible to recover structure of welding with micron lateral and depth resolution (60-120 μm). Impulse acoustic microscopy provides detection and visualization of adhesion loss areas, both extensive and diffusive ones, in the welding zone. It has been shown the method is capable to find closed cracks and detachments areas of partial (kissing) contact, failure in contact welding.

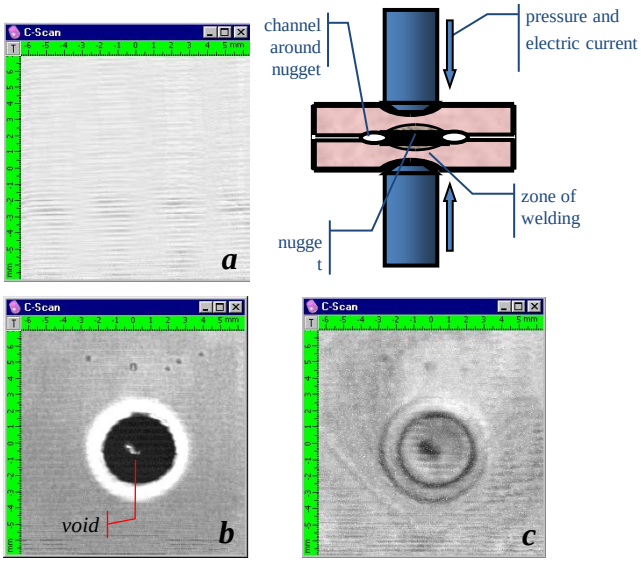
Scanning Impulse Acoustic Microscope (SIAM-1)





The microscope provides recovery of 3D microstructure inside the object bulk with resolution 10-75 μm at depth up to 10-12 mm over the area up to 250×360 mm.

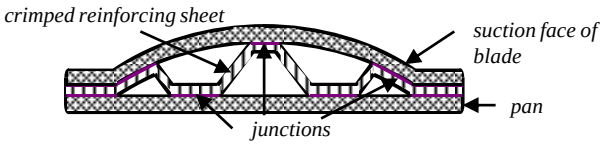
CONTACT WELDING



Acoustic image: a) surface; b) contact interface; c) bottom

DIFFUSION WELDING

Structure of hollow turbine blade

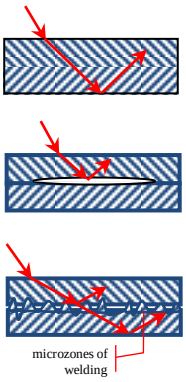


Problems

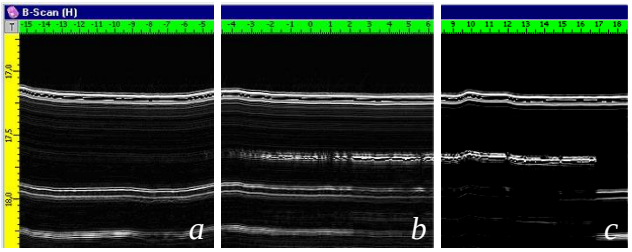
- to inspect quality of the solid-phase junctions
- to reveal possible defects of welding joints
- to determine sizes and position of defects

Imaging diffusion welding joints

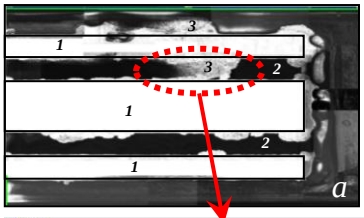
ideal joint - homogeneous contact area between two plates. No interface between coupled plates, no ultrasound reflection from the junction.
contact defoliation – macroscopic-scale plain voids at the interface between the coupled plates. Total ultrasound reflection from the defoliation; no radiation transmitted through the interface. Defoliation thickness may be micron-sized, sub-micron sized and nano-scaled (up to interatomic distances).
kissing contact – numerous sub-micron areas of tight diffusion contact. Partial reflection from the contact area and partial transmission through it.



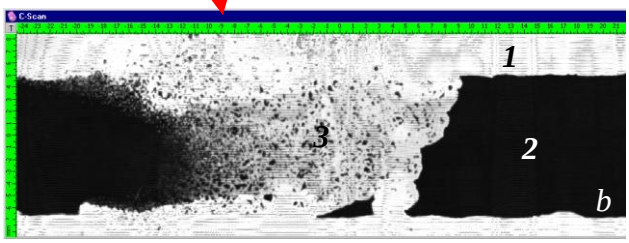
Detailed acoustic image of the partial contact



B-scans for areas with diverse quality of welding: a) good welding; b) kissing contact; c) zone of single plate or spill



1 **– zones of single plates**
2 **– zones of reliable welding**
3 **– zones of partial (kissing) contact**



C-scans of welding contact zone : a) welding area in total; b) area of kissing contact.

CONCLUSIONS

Our experimental results demonstrate that the impulse acoustic microscopy is a powerful nondestructive method of monitoring and quality assessment of turbine blades and other types of mechanical engineering products. The method makes it possible to reveal and display defects of weld joints at the contact interface. The lateral and depth resolution of the method is about 50 μm at different depth position of the welding interface. It has been shown the method enables to reveal standard defects – voids, open cracks and defoliations etc.; as well as failures unavailable for revealing by conventional NDT techniques – close cracks and detachments, areas of partial (kissing) contacts.