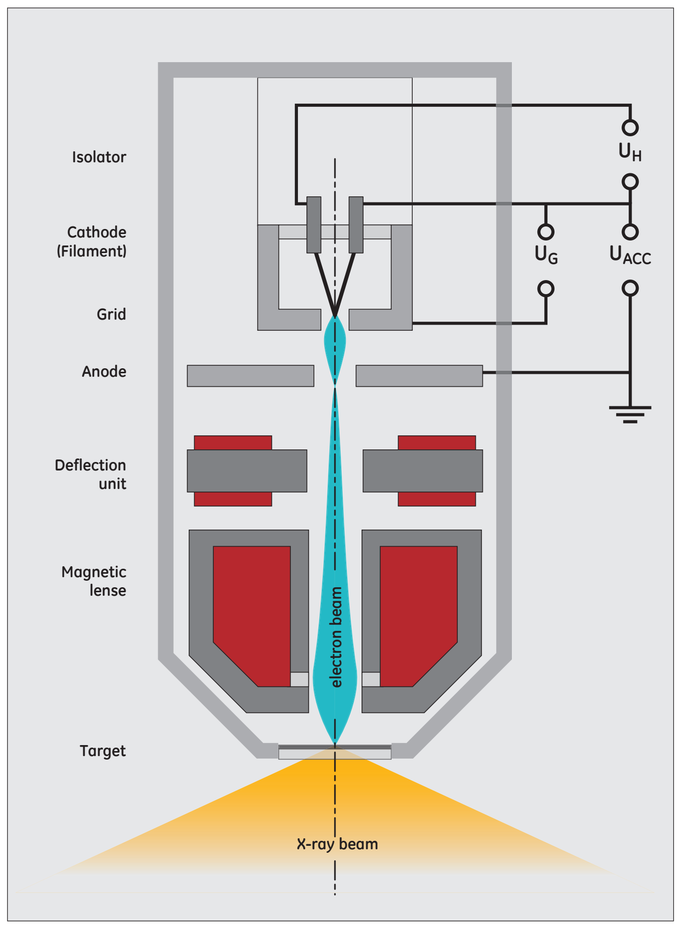
GE

Inspection Technologies

Principles of 2D X-ray Inspection

Main Components

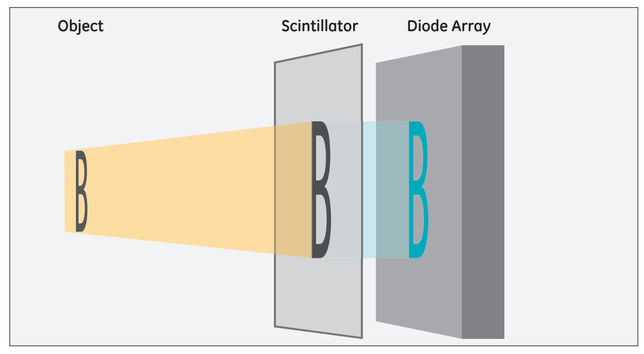


Microfocus X-ray Tube

In an evacuated tube electrons are emitted from a heated filament and are accelerated towards the anode by the potential difference U_{ACC}. Electrons enter through a hole in the anode into a magnetic lens which focuses the electron beam to a small spot of a few microns in diameter on the target. The target consists of a thin layer of tungsten deposited on a diamond or light metal plate which also serves as an exit window for the X-radiation (transmission tube). In the tungsten layer the electrons are abruptly decelerated whereby X-rays are generated. Hence, the focal spot represents a very small X-ray source which enables sharpest imaging with micrometer resolution even at high magnification. Latest nanofocus tubes achieve a detail detectability down to 200 nanometers (0.2 microns) by using multiple electron lenses. The electron beam current is controlled by the bias voltage U_G via the Wehnelt electrode („grid"). A set of deflection coils aligns the electron beam with the optical axis of the lens. Since the focal spot is located at a short distance of merely 0.4 mm from the outer surface of the exit window, the cone of X-rays spreads over an angle of 170°.

Digital Detector Array

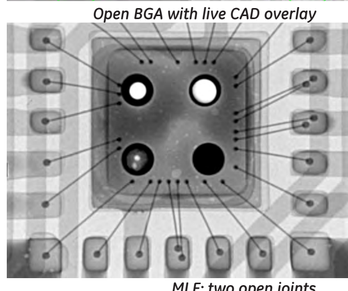
The X-ray shadow image is converted by a scintillator foil to visible light which is directly detected by a photo diode array. Main advantages of this technique are the undistorted image as well as the high dynamics and the superior contrast resolution. Latest temperature stabilized high dynamic GE DXR digital detector array technology ensures brilliant live imaging with up to 30 frames per second.



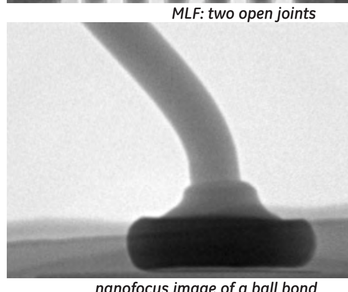
Flash! Filters image optimization

For faster and more reliable visual defect detection, Flash! Filters™ technology automatically filters the grey values present in the X-ray image to optimize contrast and brightness for the human eye.

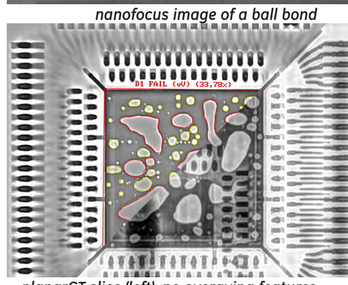
Open BGA with live CAD overlay



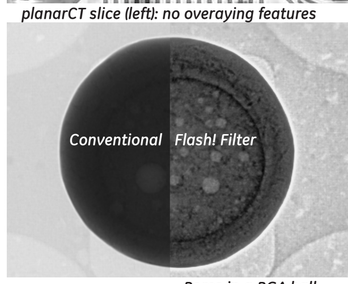
MLF: two open joints



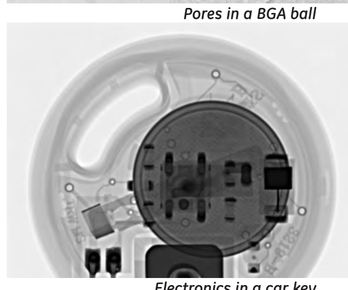
nanofocus image of a ball bond



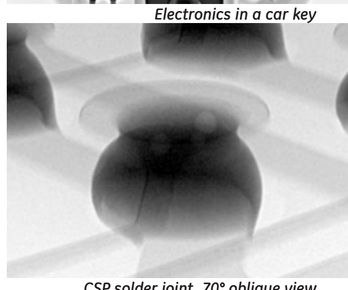
planarCT slice (left): no overaying features



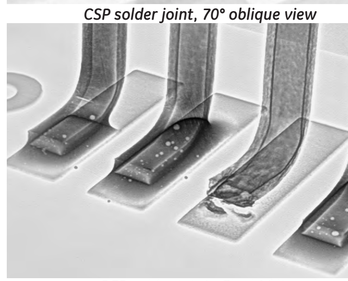
Pores in a BGA ball



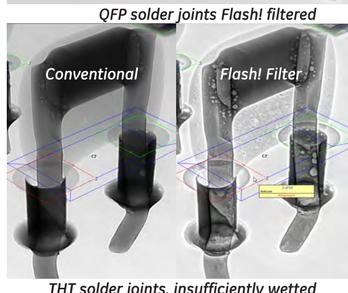
Electronics in a car key



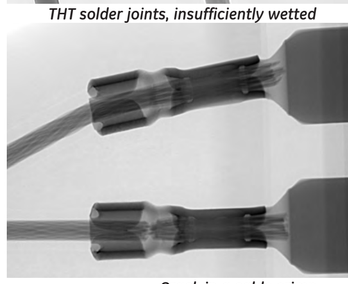
CSP solder joint, 70° oblique view



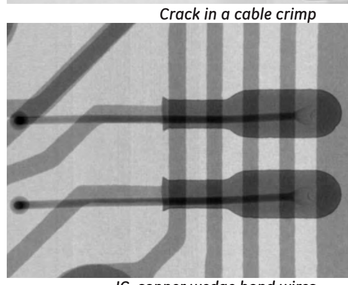
QFP solder joints Flash! filtered



THT solder joints, insufficiently wetted

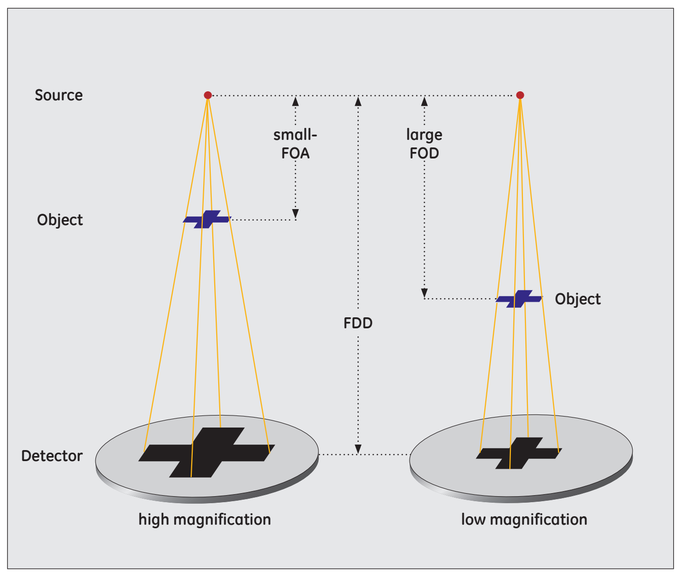


Crack in a cable crimp



IC, copper wedge bond wires

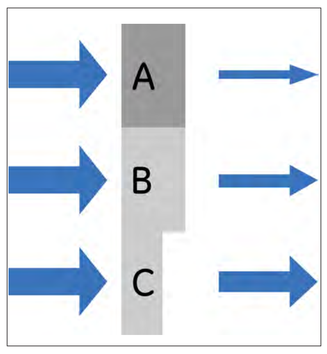
Principle of Operation



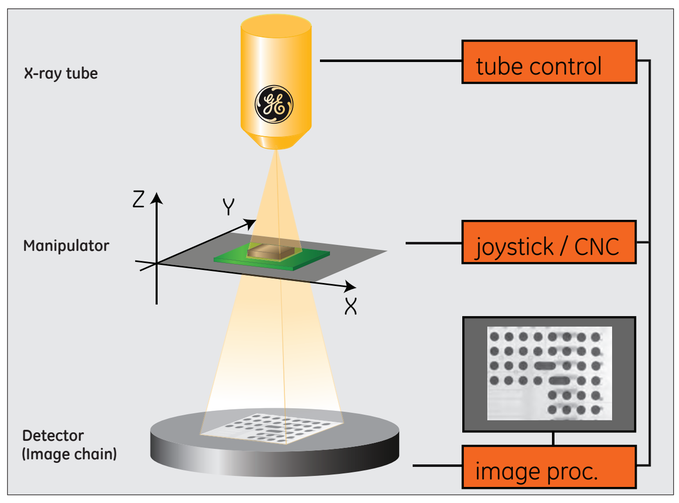
X-ray Shadow Microscope

In microfocus X-ray inspection the specimen is irradiated by a cone-shaped X-ray beam so that a magnified X-ray image is produced on a detector. The detectability of a defect through the image is ruled by three quantities: magnification, resolution and contrast. The achievable resolution (image sharpness) is mainly determined by the size of the X-ray source which is in the range of clearly less than one micron for nanofocus X-ray tubes. The geometric magnification is given by the geometry of the X-ray beam M=FDD/FOD as illustrated (left) and can be as high as 1000fold to 2500fold at practicable distances. Apart from these quantities, the recognition of an individual object feature depends on the contrast induced by this feature to the image. Physically, the contrast originates from different X-ray absorptions of different object areas which can be caused by varying thickness as well as by varying material:

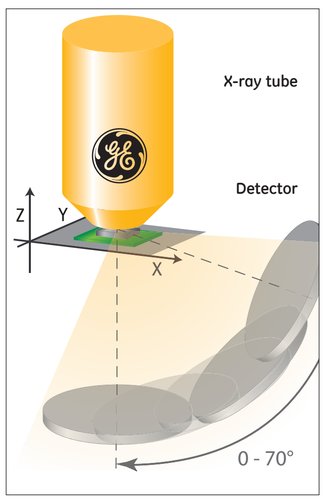
In the right image object A is of the same thickness as object B but yields a higher absorption due to higher density or higher atomic number. Object C consists of the same material as object B but absorbs less radiation than the thicker object B.



Systems



Set-up of a X-ray system with transmission tube, manipulator and vertical X-ray beam. The magnification is selected by adjusting the Z-position of the specimen. Processor based control units enable automated inspection cycles and image evaluation.



ovhm-Technology

(oblique view at highest magnification)

Any tilting of the sample dramatically reduces the achievable magnification due to longer focus-object distance.

By tilting the detector in the wide beam cone of the transmission tube angled inspection can be performed with undiminished magnification.

- 180 kV / 15 W
- Detail detectability: down to 200 nm
- Optical zoom: > 24.000 x
- Max. sample size: 680 mm x 635 mm (27" x 25")
- High dynamic live inspection with GE´s unique temperature stabilized DXR detector technology
- CAD-based automated programming
- Live overlay of CAD data in the X-ray image

phoenix nanome|x, GE's automated high-power nanofocus 180 kV / 15 W X-ray system for the inspection of high-end interconnection technology in the semiconductor and SMT industry with the option of advanced 3D planarCT as well as high resolution nanoCT®.

GE imagination at work

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