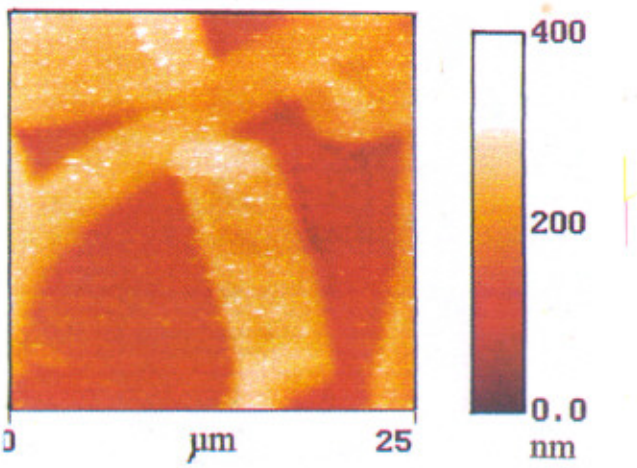
LASER PROGRAMME

Laser induced fluorescence diagnosis of cancer

Laser induced fluorescence spectroscopy of human tissues is being actively pursued for sensitive, in situ, near real time diagnosis of cancer (see CAT Newsletter June '95). Recent work carried out at CAT on breast tissue samples has shown that with the use of 337 nm N_2 laser excitation the cancerous breast tissue sites are significantly more fluorescent compared to the normal and the benign tumor tissue sites. Therefore, the use of fluorescence intensity alone as the discrimination parameter could provide very good discrimination between the cancerous, normal and the benign tumor tissues. Sensitivity and specificity values of ~100 % were achieved in this in-vitro study involving 65 patients with breast tumor. Further, the studies carried out at CAT showed that the discrimination results were remarkably better with 337 nm excitation as compared with the use of 300 nm excitation being used in a prototype commercial system being developed elsewhere. Possible reasons for the improved discrimination with 337 nm excitation have been identified. Studies have also been carried out on the cancer of oral cavity. In contrast to breast malignancy, malignant tissue in the oral cavity was characterized by a significant reduction in the fluorescence intensity. In a study, involving 50 patients with cancer of oral cavity, the discrimination algorithm developed to quantify the observed differences in autofluorescence spectra could provide sensitivity and specificity of ~95% for discriminating malignant tissue from the normal tissue.

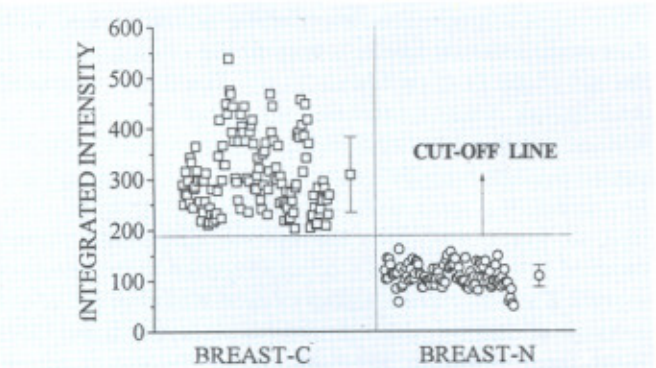
X-ray contact microscopic imaging using laser produced plasmas

Intense x-ray emission from laser produced plasma has been used for single shot x-ray contact microscopic imaging of physical and biological microstructures. This basically involves making a contact shadowgram of a sample placed on a photo-resist coated surface, by exposing it to a high brightness, short duration (~nsec) burst of soft x-rays from a point source like laser produced plasma. After exposure, the latent image of unit magnification in the photoresist is chemically developed to yield a relief pattern. Since the etching depth at a given point on the photoresist depends on the x-ray dose received, the recorded image represents a two-dimensional topographical map of integrated x-ray attenuation of the sample. Spatial resolution in the range of 50 to 200 nm, governed by diffraction and penumbral blurring, can be obtained depending on the x-ray source size and the sample thickness.

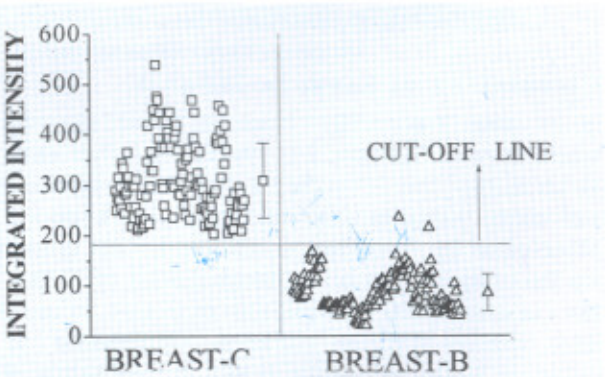


Atomic Force Microscopy scan of x-ray image of yeast cells

Soft x-ray source was produced by focussing 10 J, 28 nS (FWHM) Nd:glass laser pulses on a planar copper target to a spot diameter of ~130 µm at a laser intensity of $2x10^{12}$ W/cm^2. Imaging of fine copper grid and free-standing gold transmission grating microstructures was done on a ERP-40 photoresist coated silicon wafer to characterize the spatial resolution and the x-ray dose requirement. A spatial resolution of 195 nm was observed from the image of a 10µm thick copper mesh in a single shot x-ray exposure of ~10mJ/cm^2 (for hν ≥ 0.8KeV). Further, experiments on imaging of biological samples were carried out in collaboration with P N Lebedev Physics Institute, Moscow. X-ray images of yeast and fungus cells were recorded with an estimated resolution of ~120 nm. Figure above shows an Atomic Force Microscopy picture of the image of the yeast cells alongwith a height profile distribution. Important role of x-ray imaging is noted from the high contrast and features observed in such images which are not revealed when the sample is viewed under an optical microscope. Moreover, height profile map of the developed photoresist can be used



Scatter plot for the spectrally integrated intensity of cancerous (BREAST-C) and adjoining normal (BREAST-N) breast tissues.



Scatter plot for the spectrally integrated intensity of cancerous (BREAST-C) and benign (BREAST-B) breast tissues.