The influence of different parameters in microwave near field imaging

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Introduction

Microwave near field scanning microscope has the advantages of non-destructive detection, large scanning area and wide sample types. In recent years, it has been used in the characterization and testing of micro-nano structure material samples and the microscopic study of biological cells.

Methods

1. Theory of near field

The near field refers to the confined electromagnetic field phenomenon concentrated near the material surface and the evanescent wave phenomenon inside the material. In the near-field range, the probe can store electrical and magnetic energy. When the sample is close to the probe, the stored energy of the probe will change, which will affect the electromagnetic response of the coaxial resonator.

2. Perturbation theory

In cavity perturbation theory, when there are samples with different material properties around the cavity, the electromagnetic field in the cavity will change. The variation of the system response, such as the peak S parameter, resonant frequency, is quantified by the introduction of the sample. The characteristics of the material can be determined according to the variation of these parameters.

Results

The effects of probe trajectory, scanning step size and different imaging parameters on microwave near-field imaging are discussed.

Firstly, both of "inverted L" shape and "S" shape have similar imaging resolution. However, the imaging results of "inverted L" shape will cause the image information lost because of the fast moving speed (Fig 1).

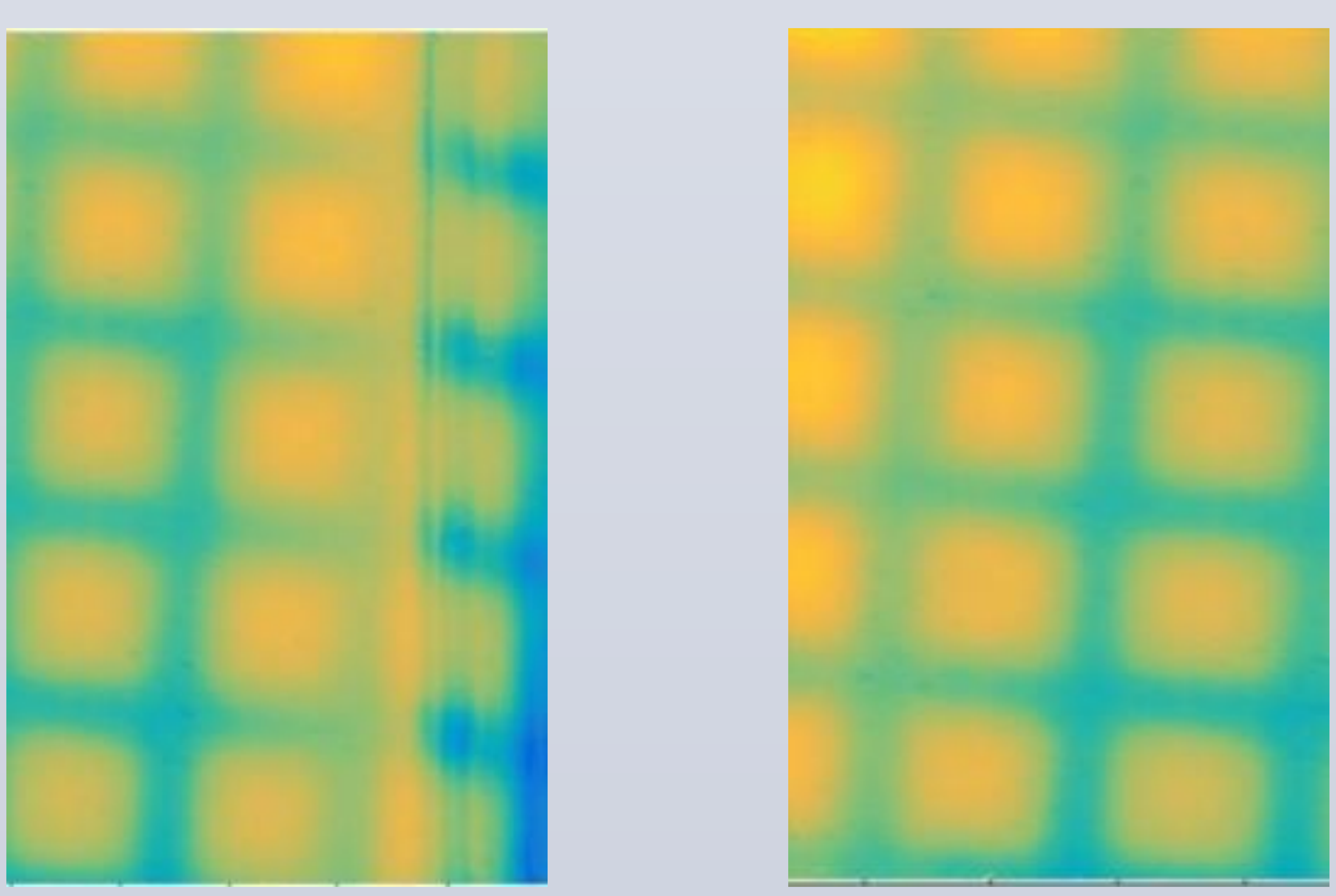


Fig. 1 (a) “Inverted L” imaging (partial data loss) (b) “S” imaging

Then, we found that the step size must be smaller than the sample size in order to obtain a distinct image. In addition, with the decrease of the sample size, the change of scan step size gradually decreases, and presents a logarithmic curve trend ultimately(Fig 2.1and 2.2).

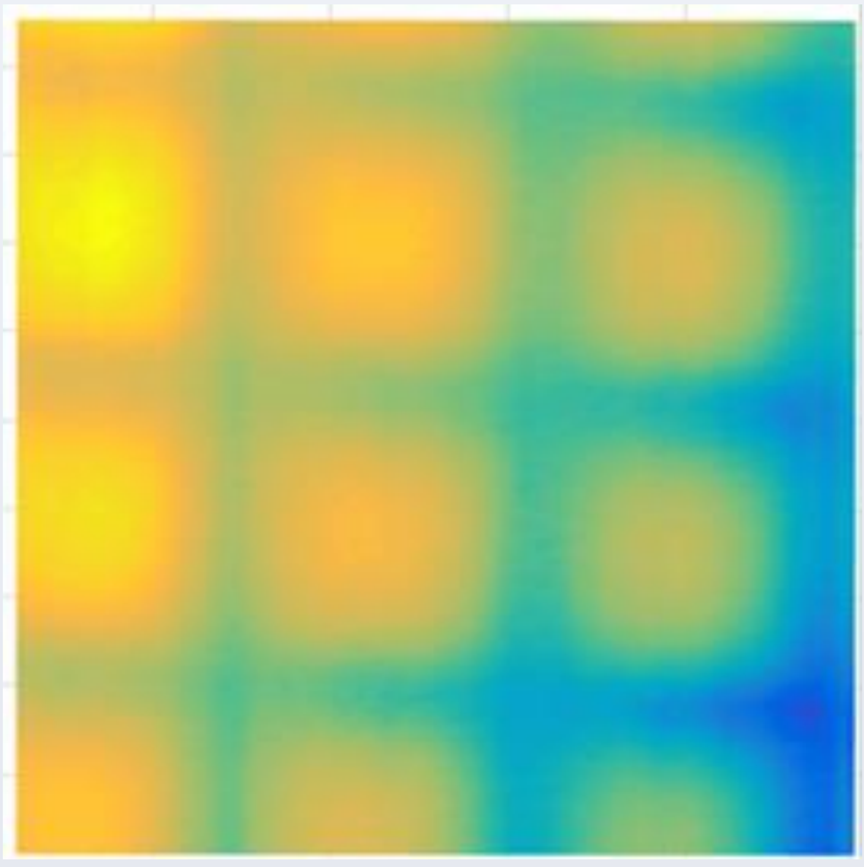
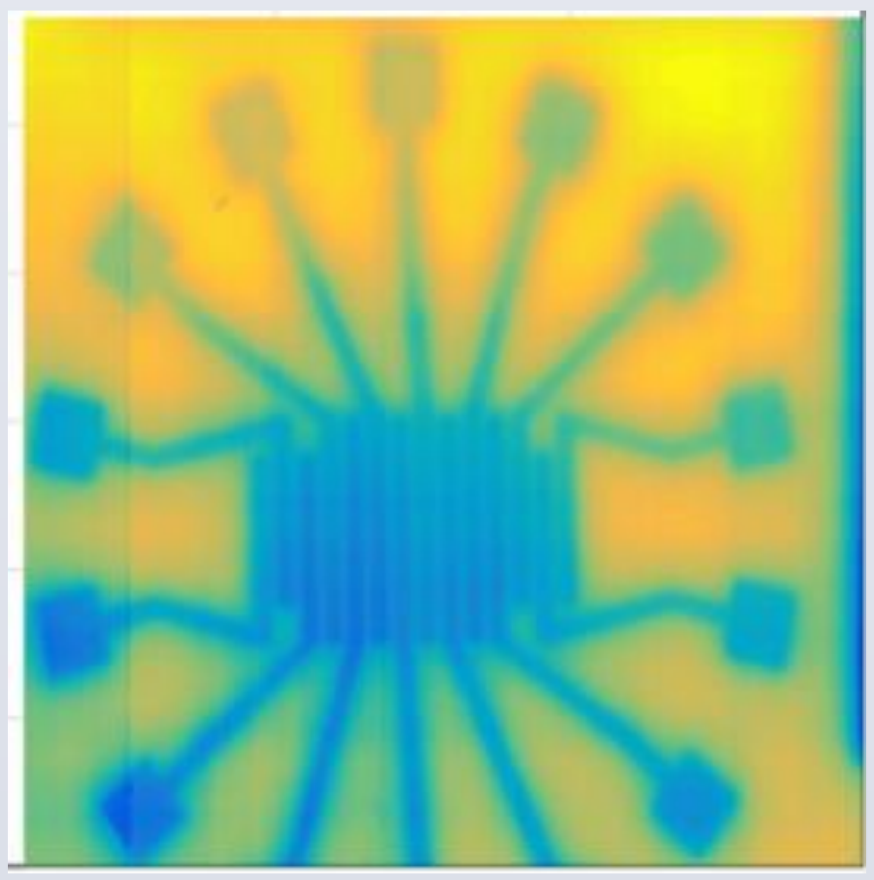


Fig. 2.1 Step size 3-4μm imaging(sample size is145μm×20μm)



Fig, 2.2 Step size 23-25μm imaging(sample size is more than 200μm).

Finally, in order to highlight the imaging effect of the non-metallic part of the sample, it is better to choose s parameters for imaging. While observing the morphology of the metal part of the sample, the resonance frequency and -3 dB bandwidth will have a better imaging.

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