

光学测试技术

绪论

卓力特光电仪器（苏州）有限公司

力学测试

无损检测



变形测试

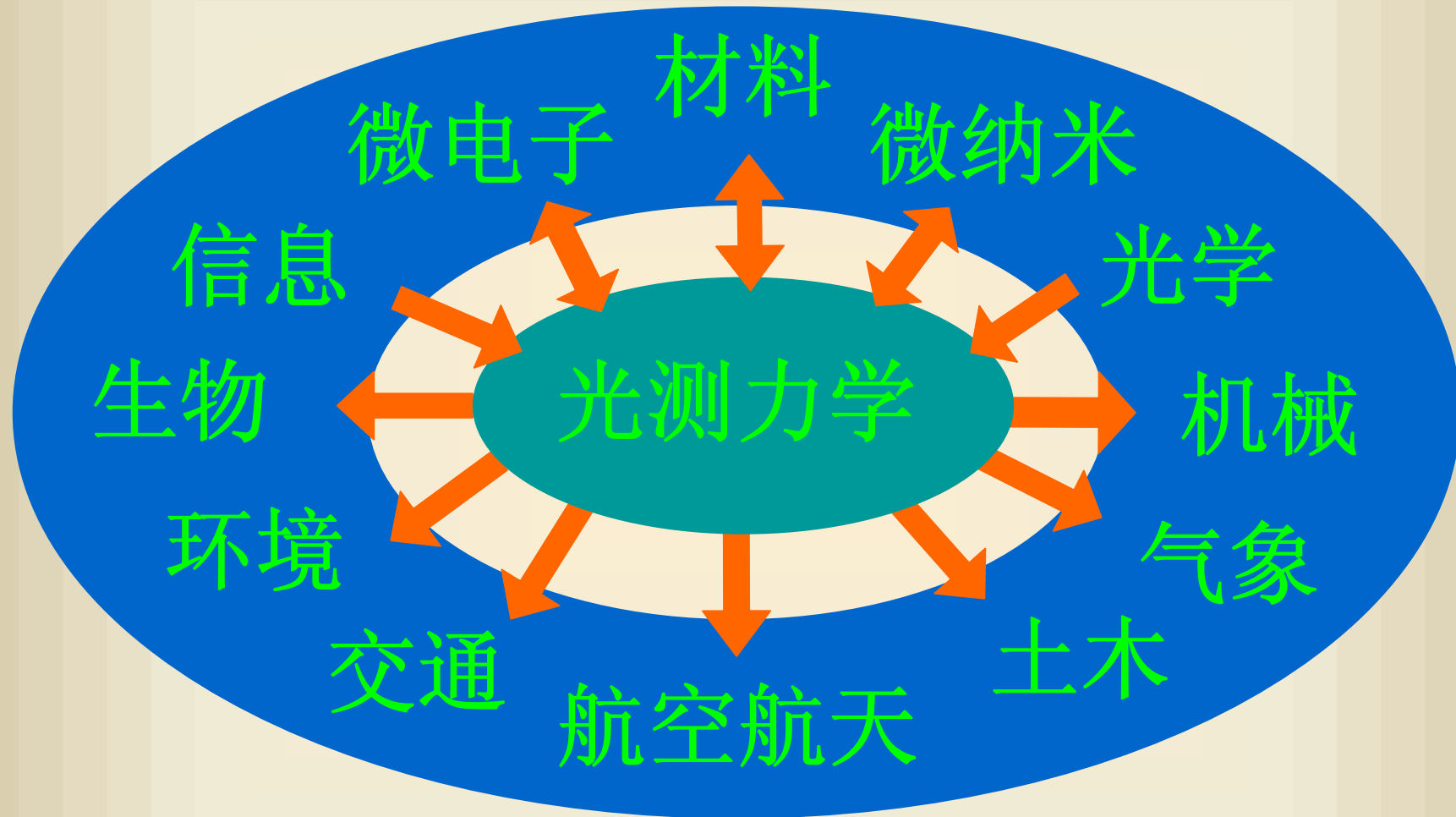


声、光、电、射线、磁、信息

光学测试技术就是运用光学技术，如光弹性、激光、全息、散斑、云纹等，以及现代电子、微机技术，如视频技术、图像处理技术等，创造了一些新的力学实验方法，把力学推向一个崭新的境地。

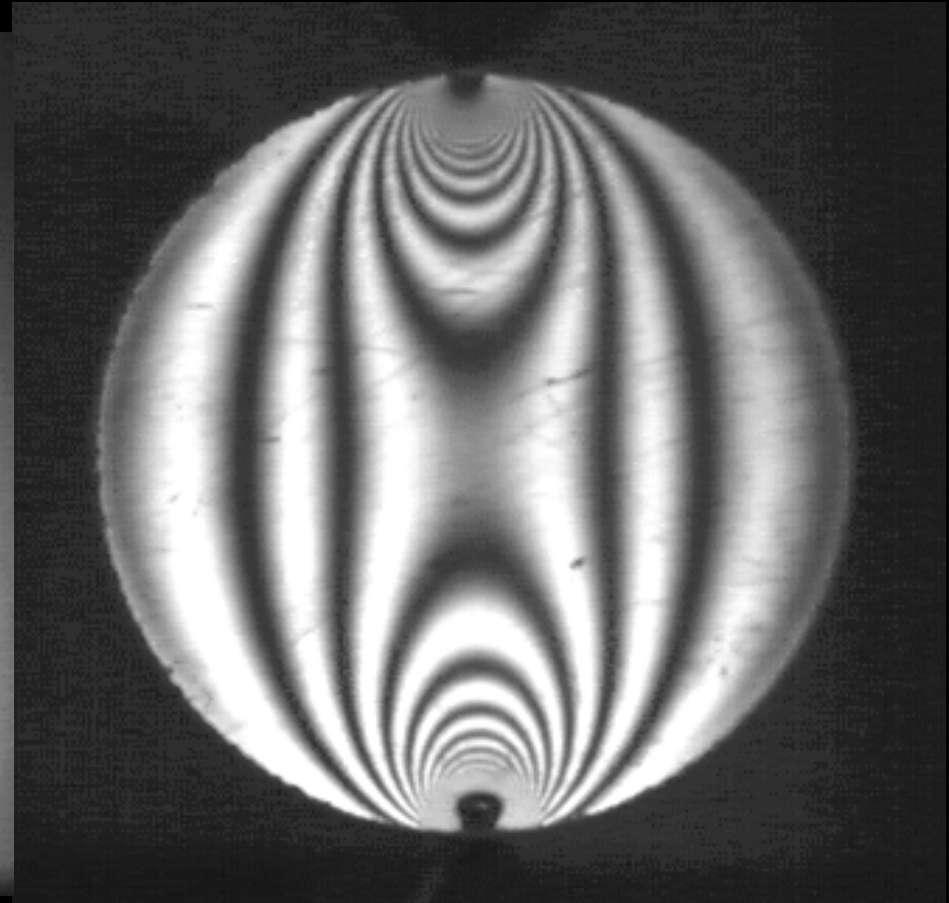
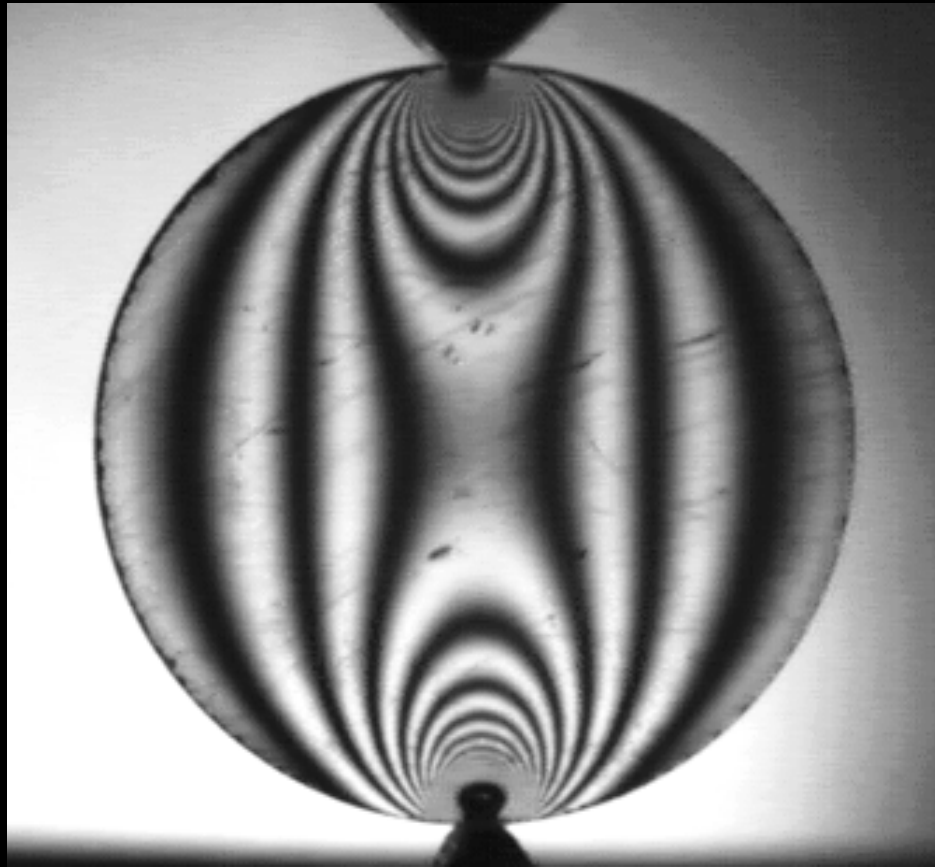
光（激光）

光弹性	利用透明材料的双折射效应测量模型的内部应力
光全息	利用光波的干涉和衍射原理检查试件的表面变形
云纹	利用规则的几何栅线测量物体表面变形
散斑	利用物体表面的随机信息测量表面变形

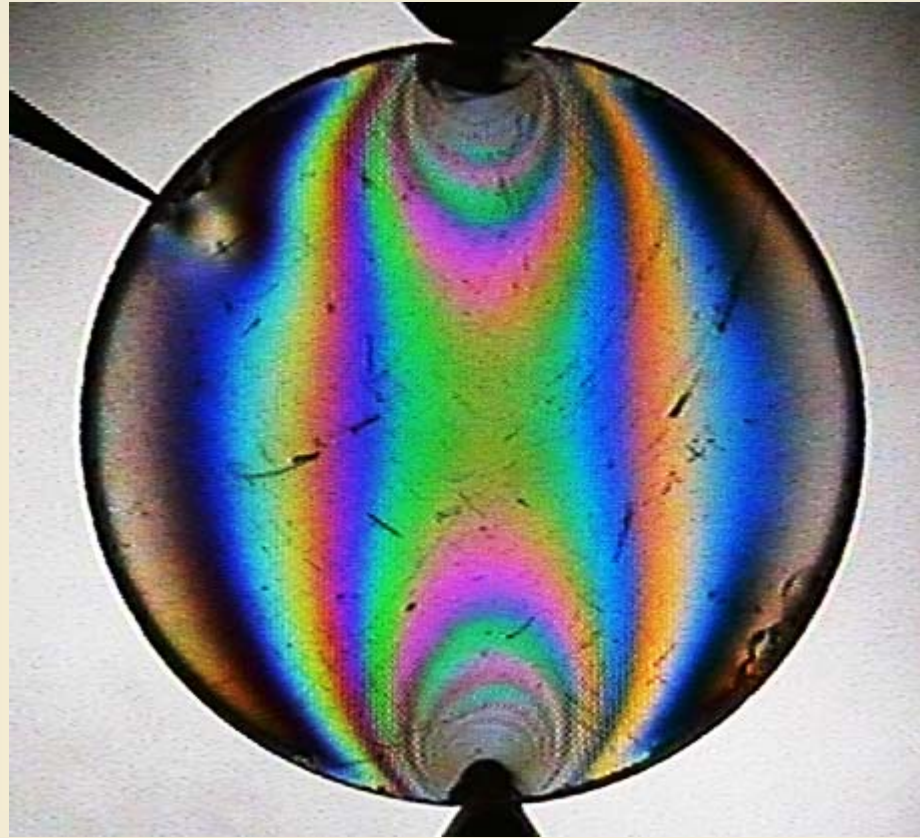


光弹性实验方法

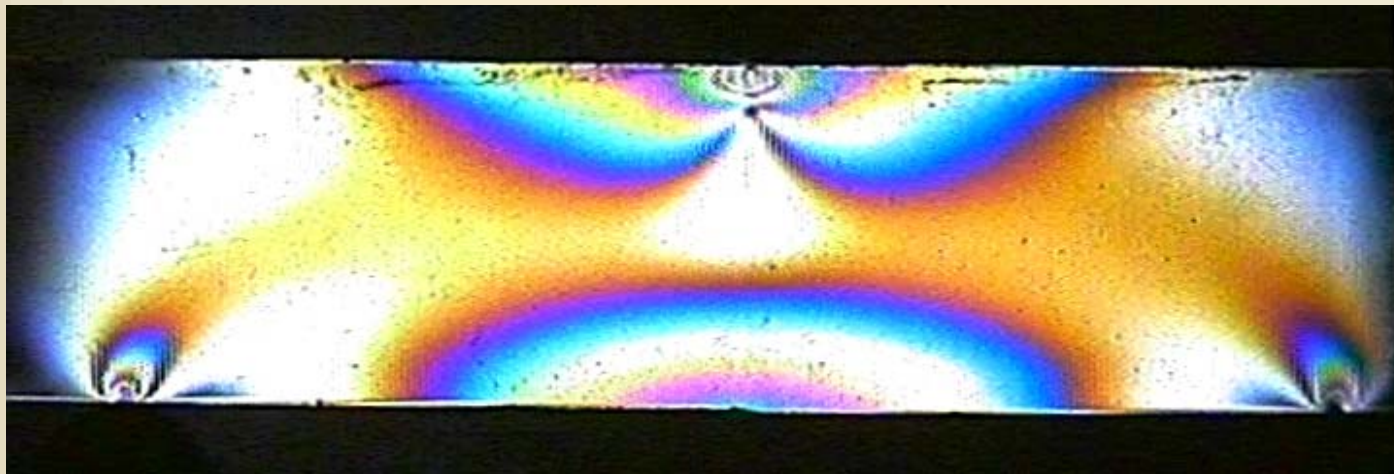
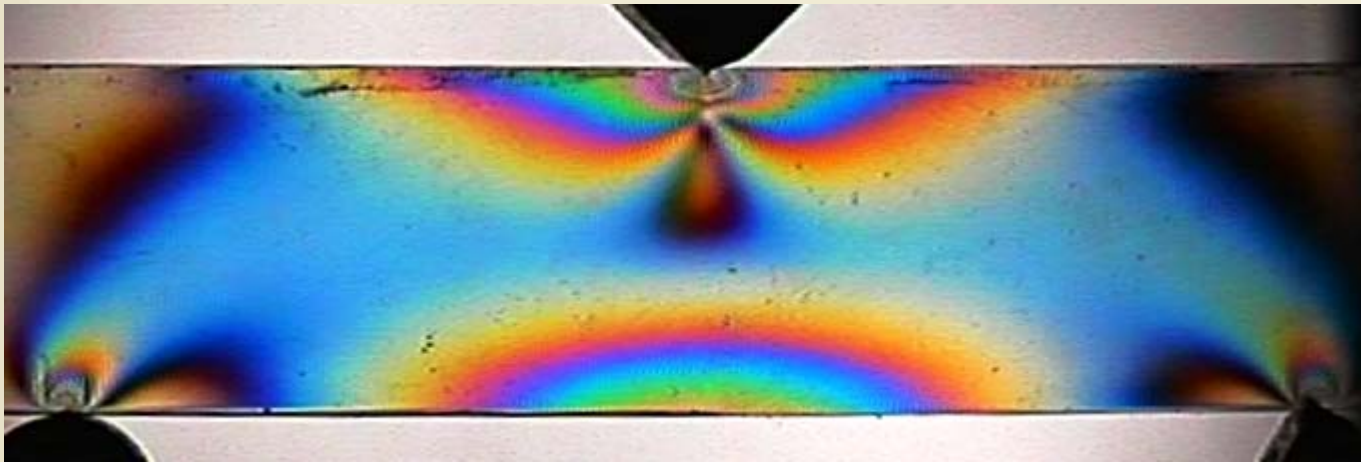
光弹性实验方法



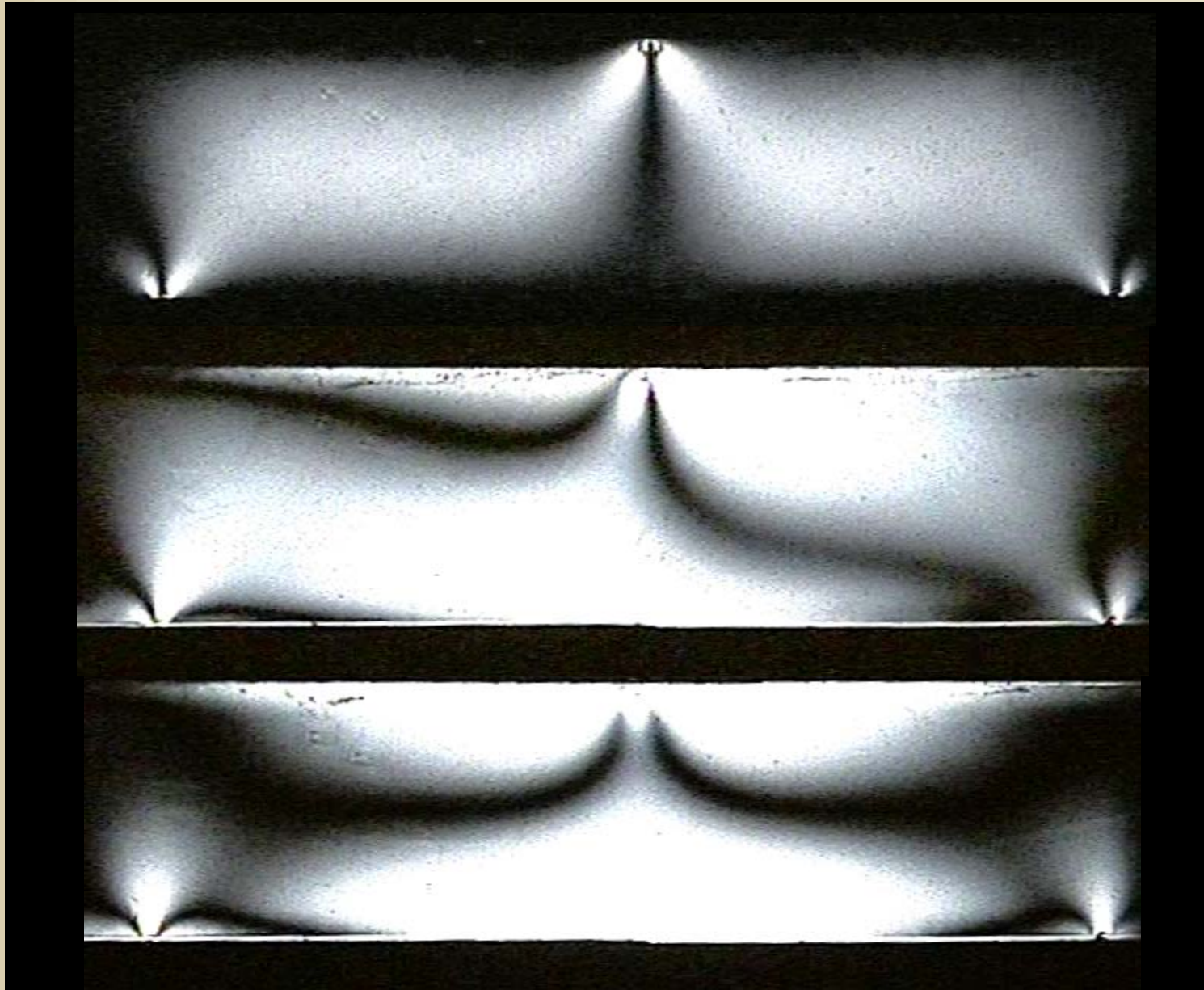
光弹性实验方法



光弹性实验方法的基本原理



光弹性实验方法



0°

20°

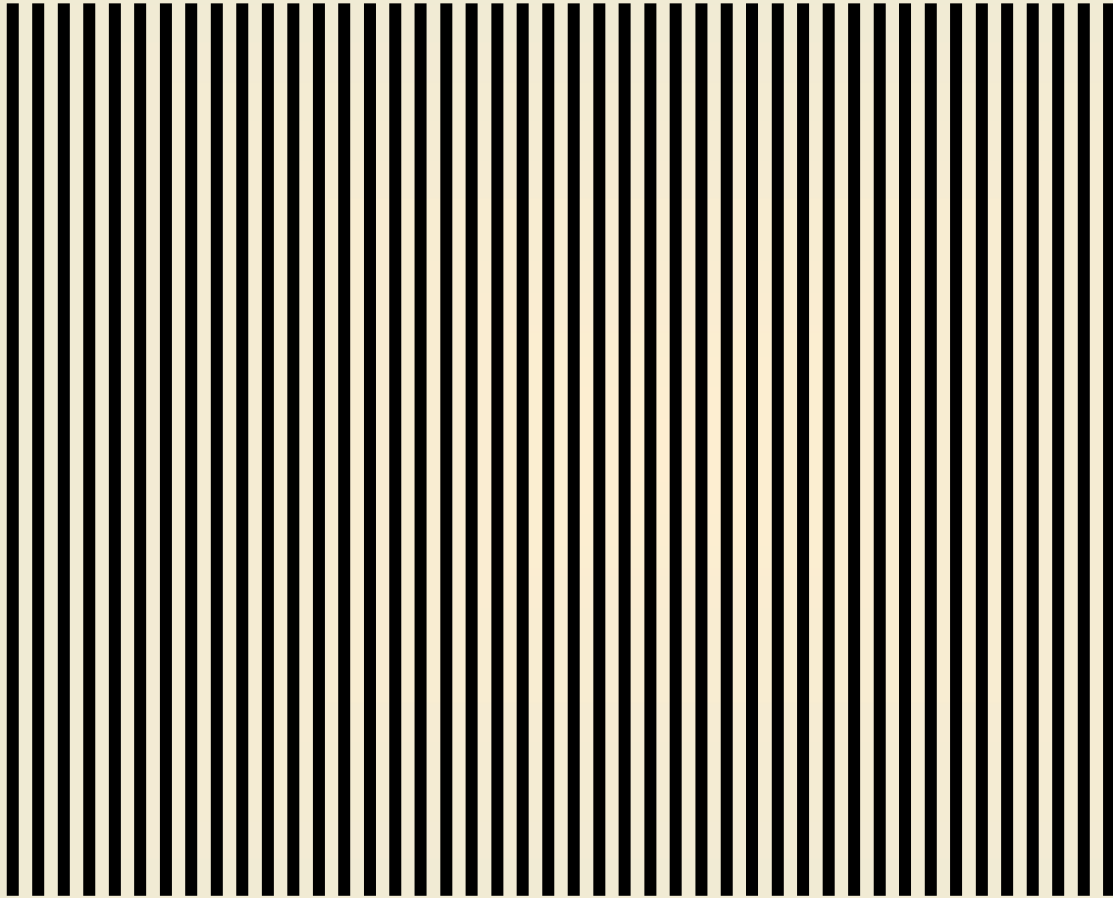
45°

云纹法

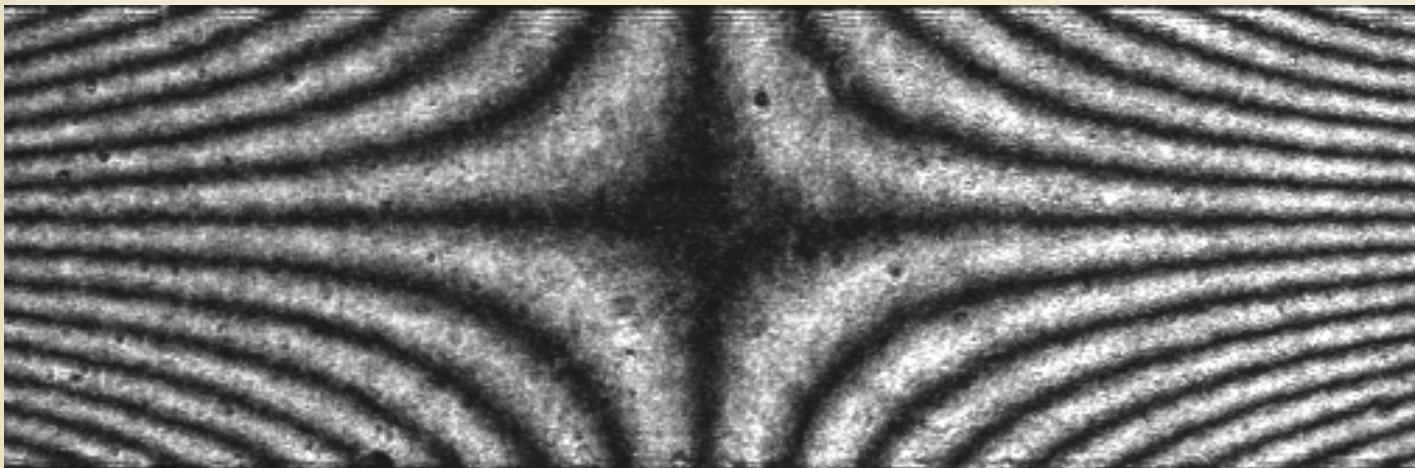
云纹干涉法

投影云纹法

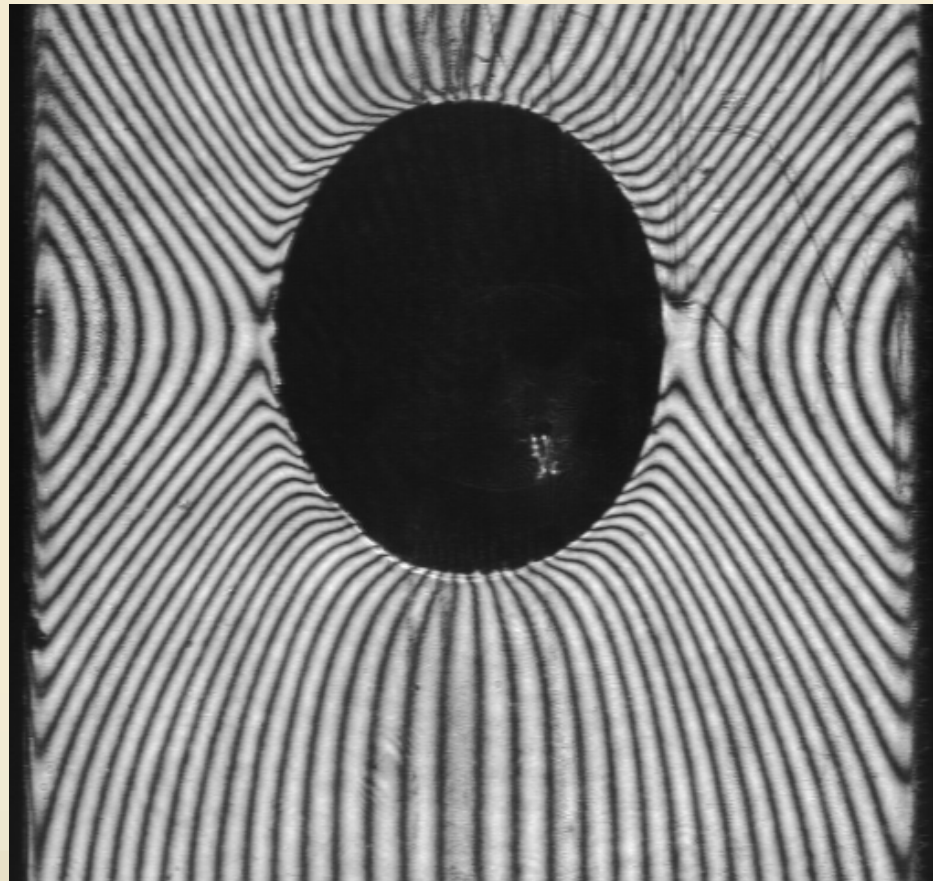
云纹干涉法



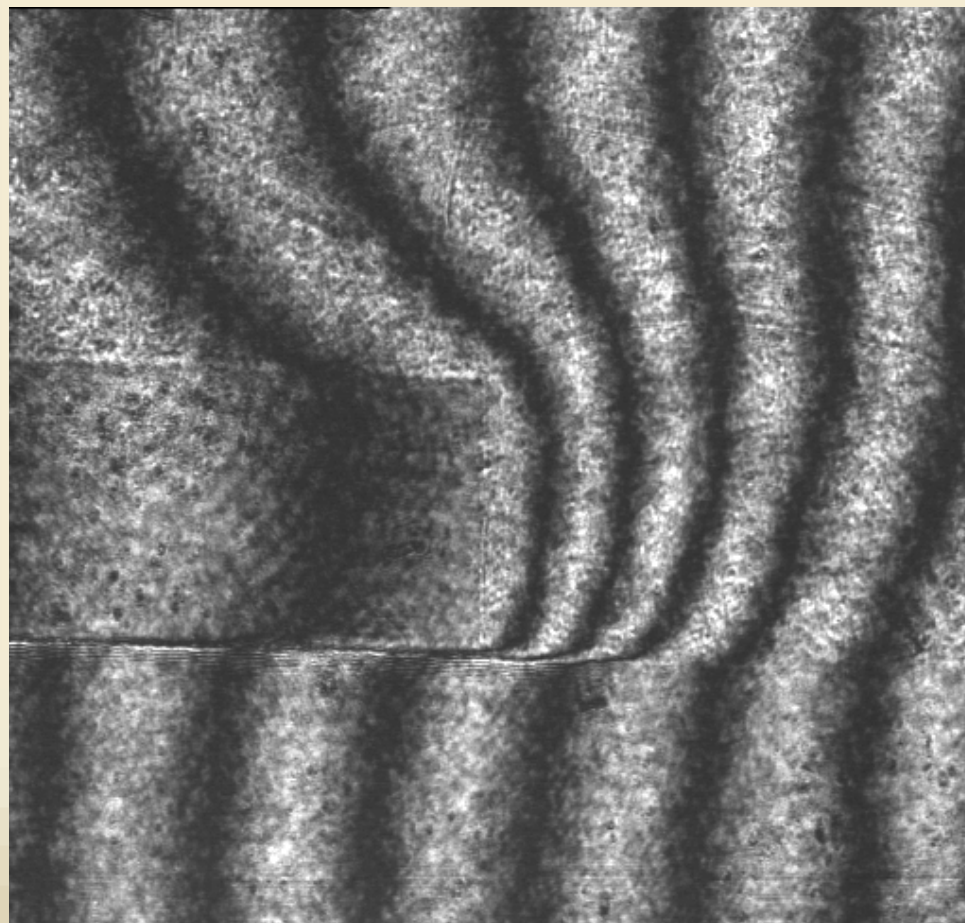
弯曲实验的云纹干涉条纹图



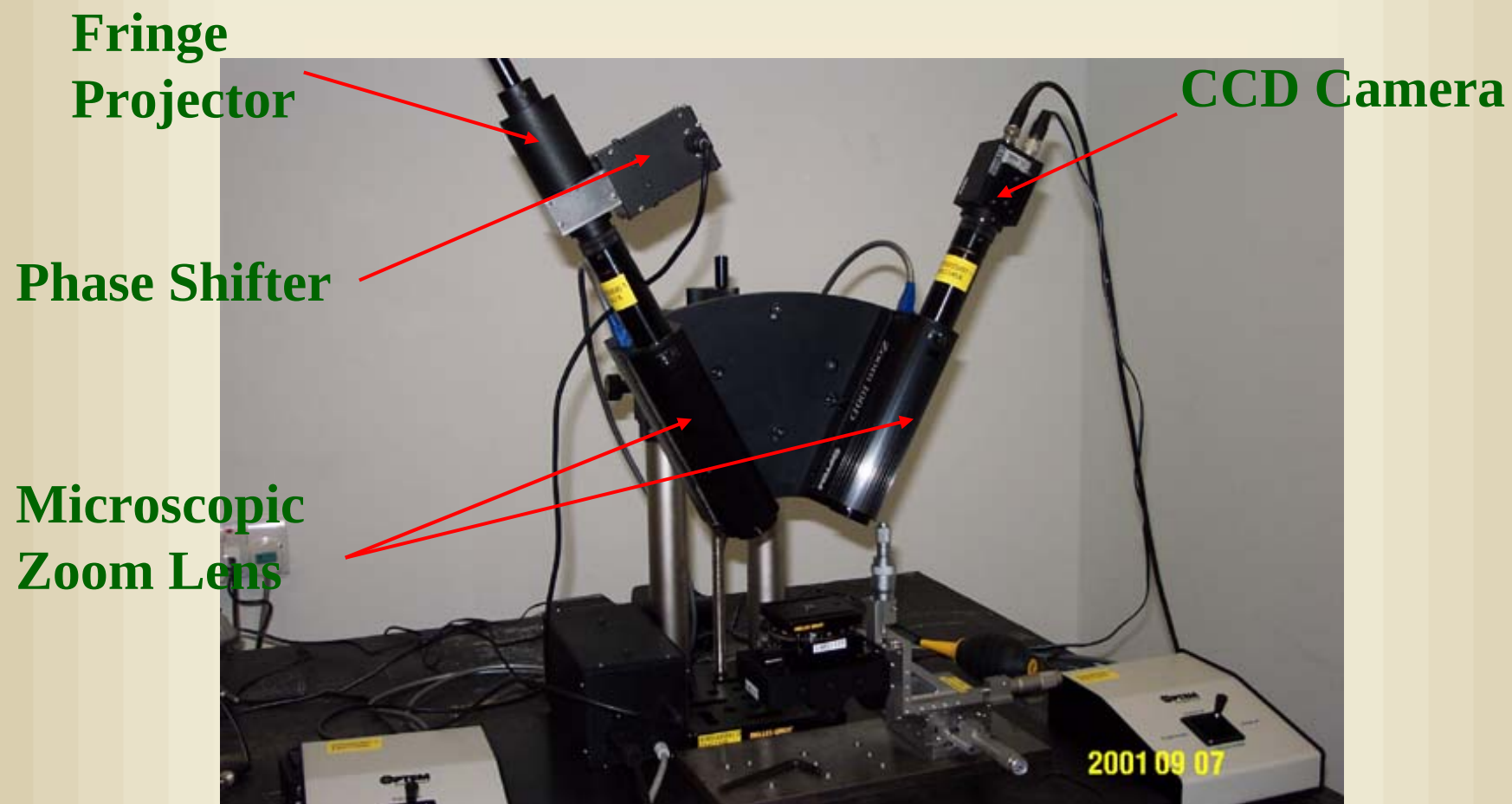
带圆孔板的云纹干涉条纹图



电源封装受热载条纹图

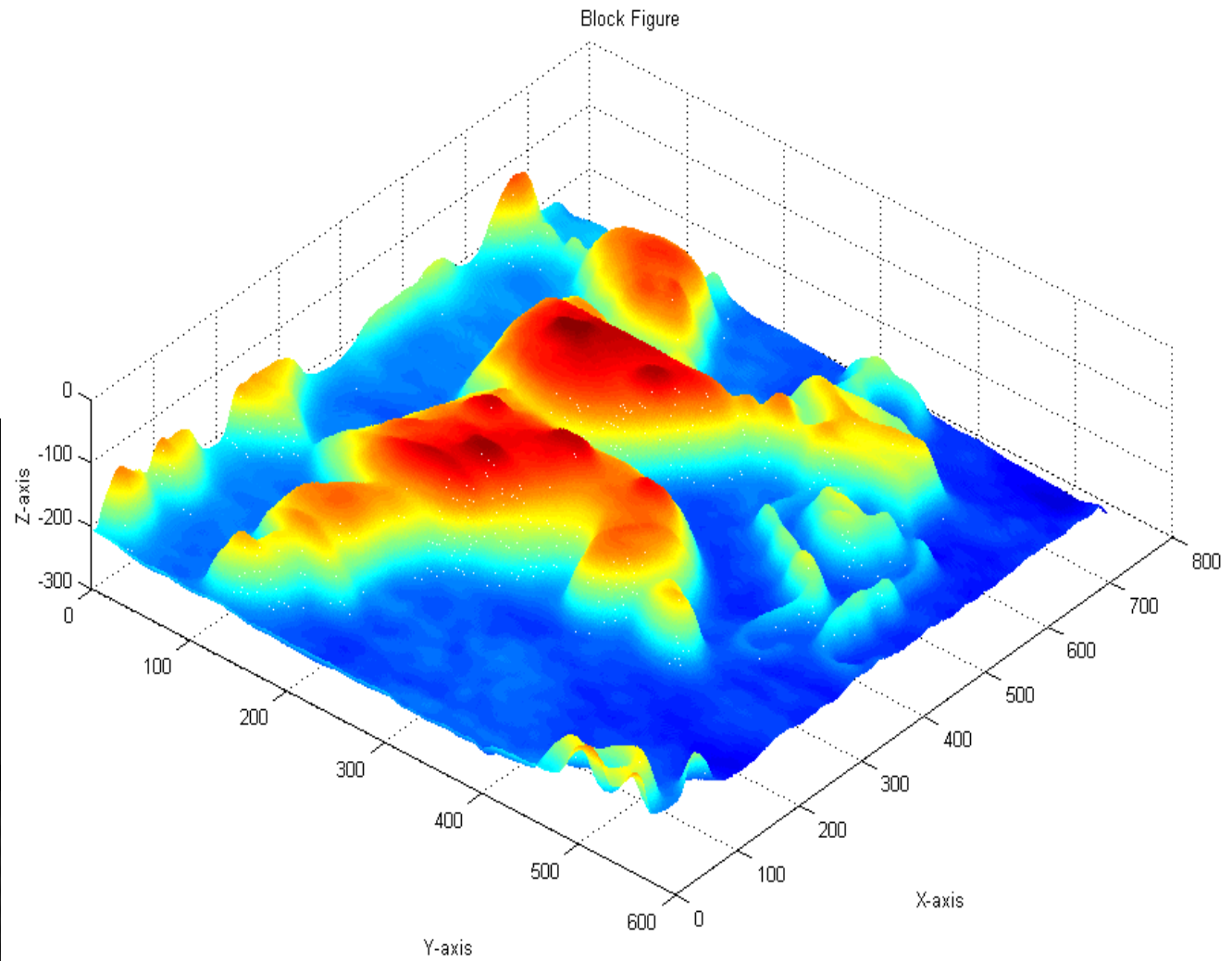
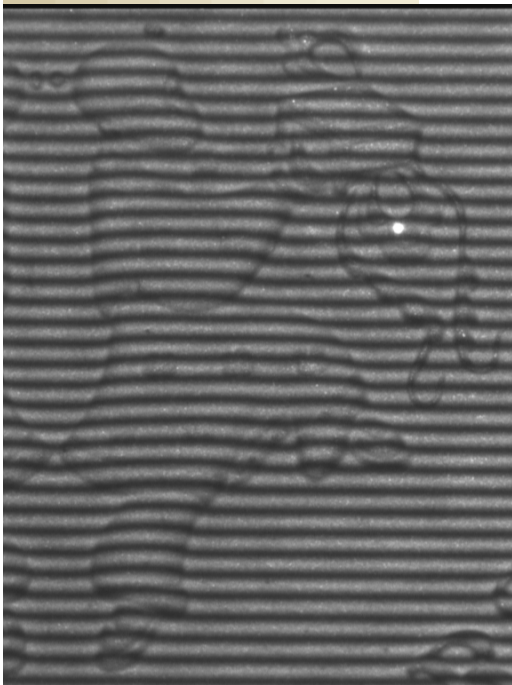


投影云纹法

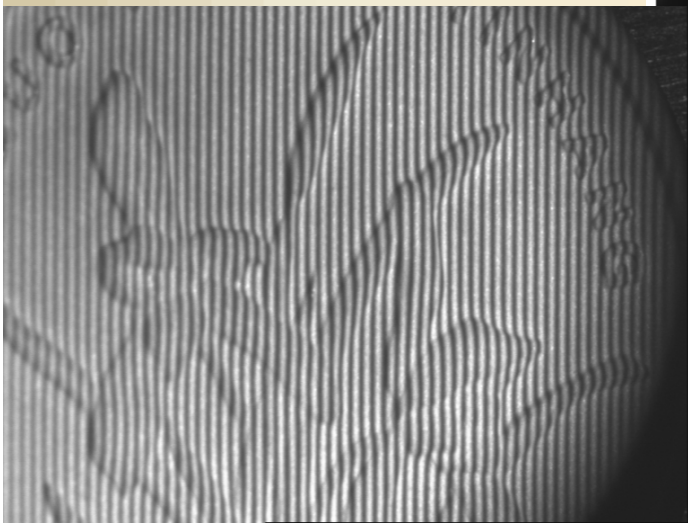


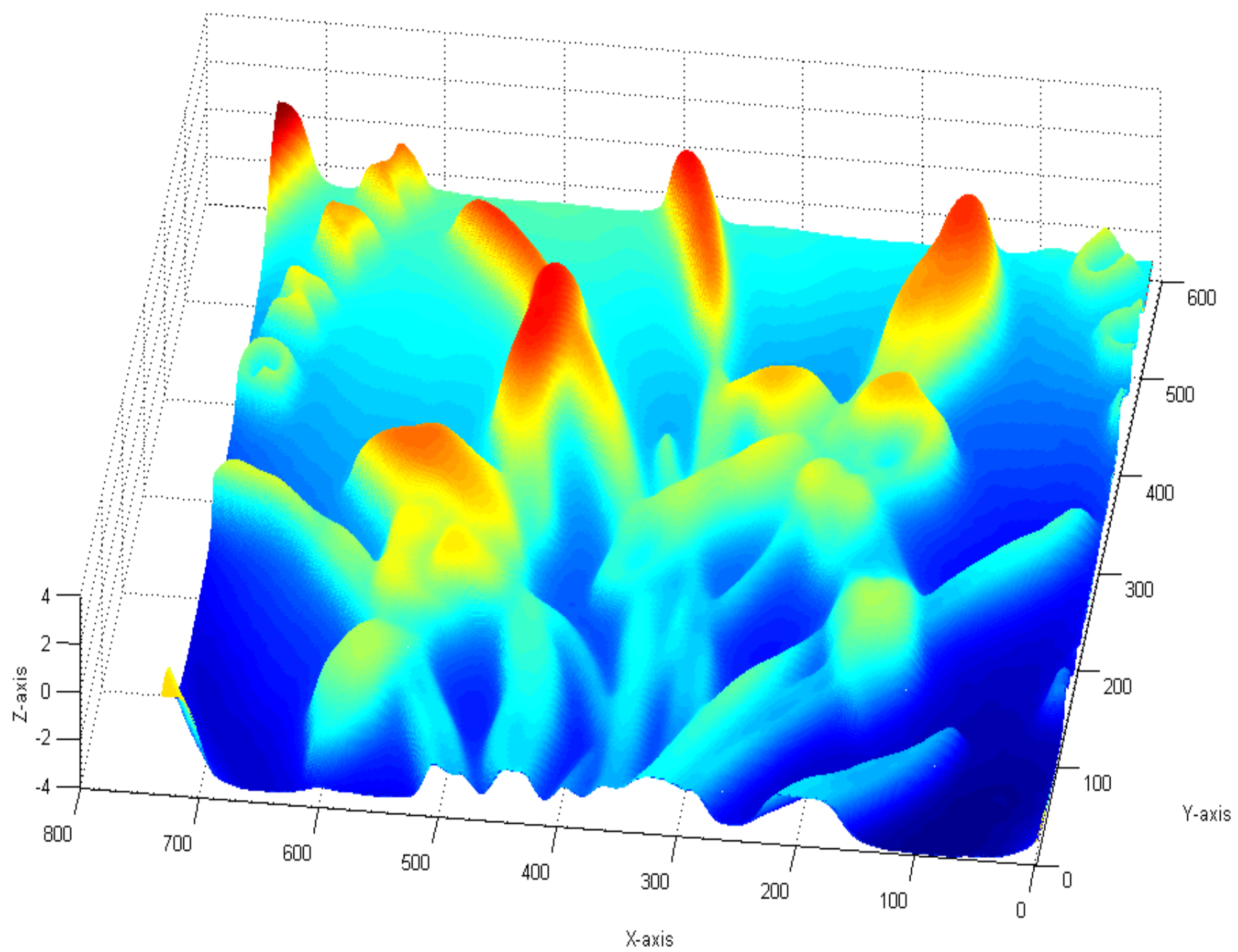
微结构测试装置

钱币三维形貌

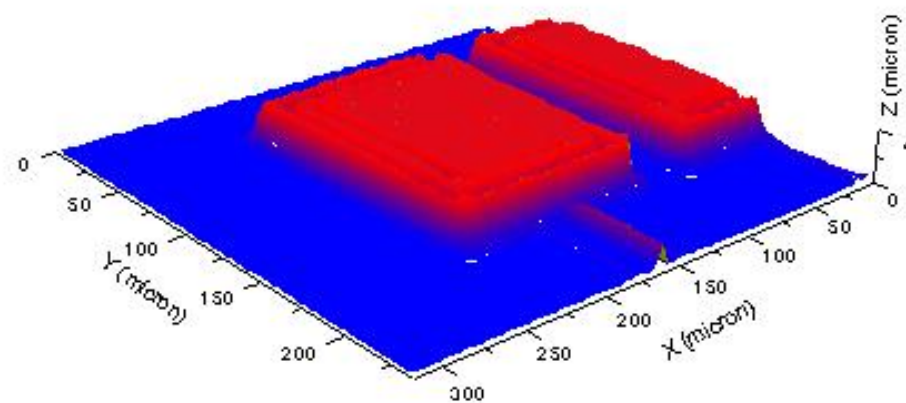
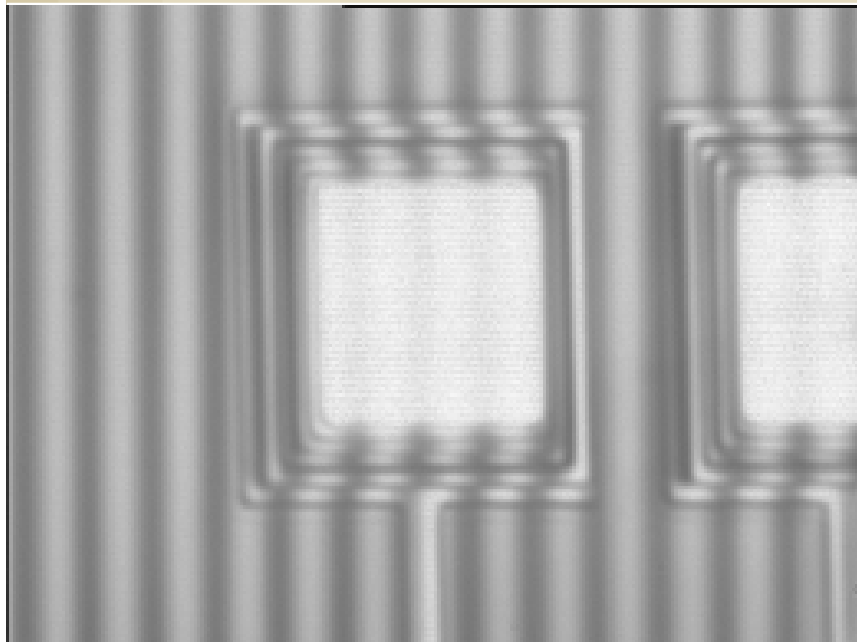


钱币三维形貌

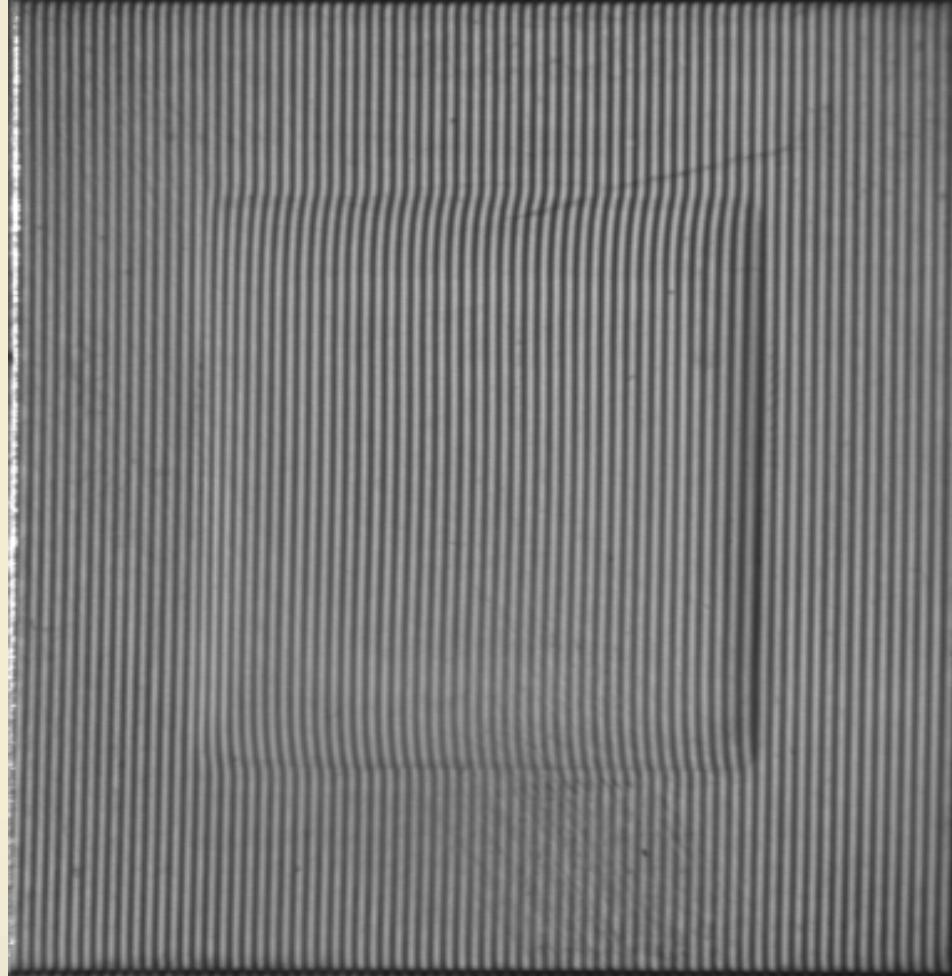




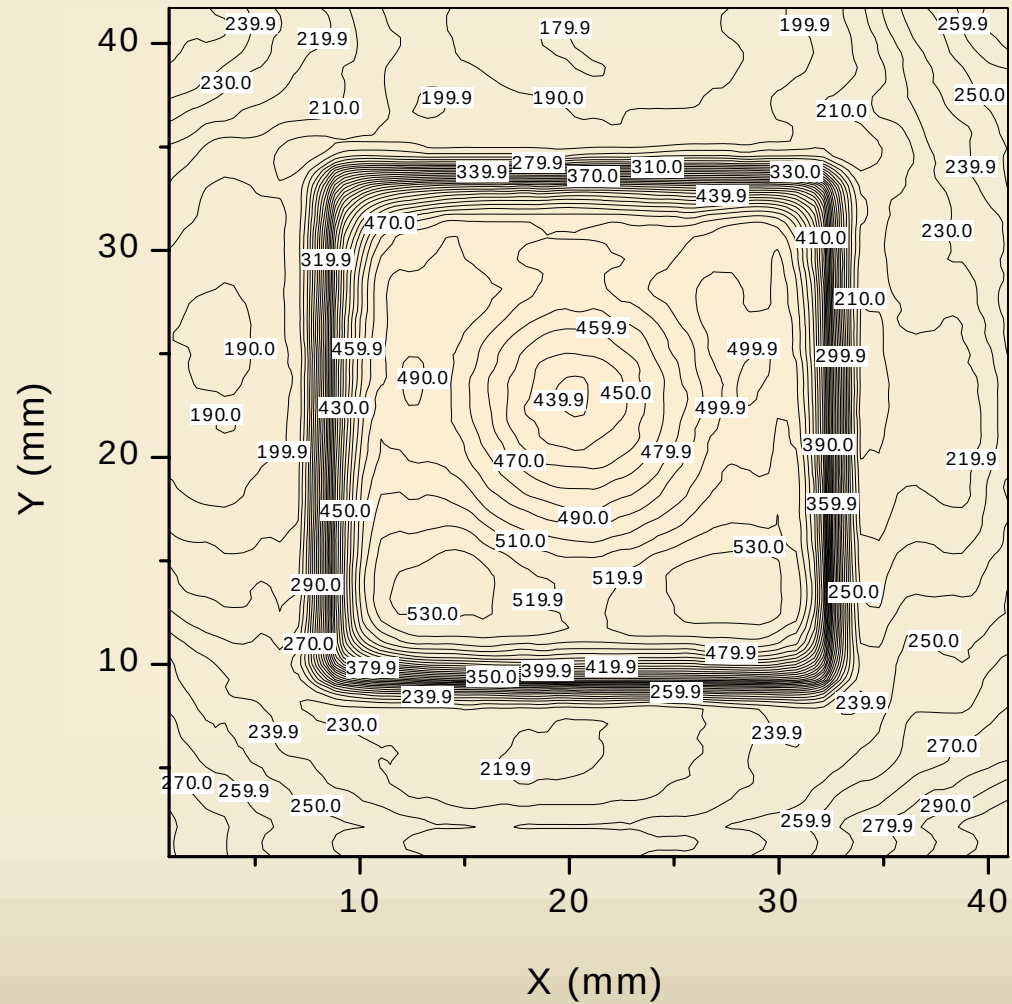
微结构三维形貌



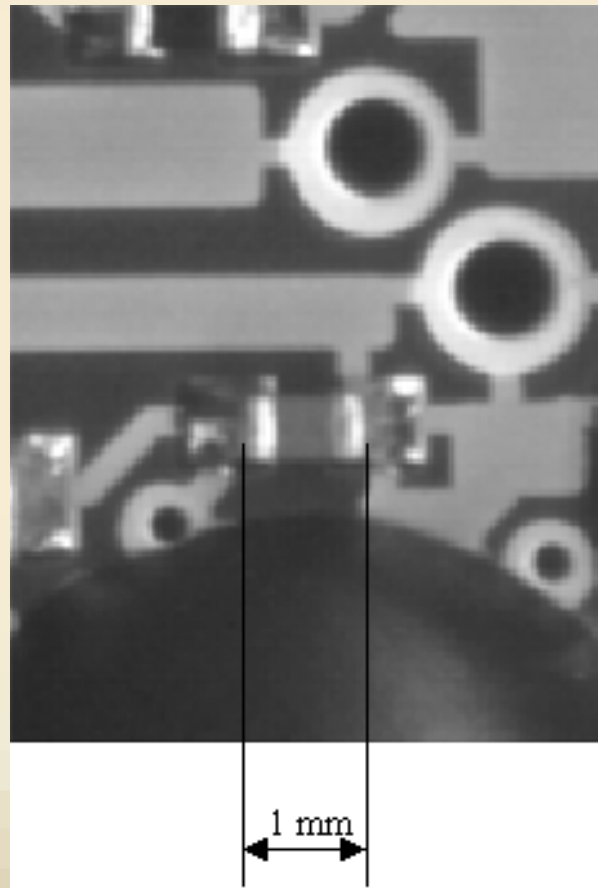
焊锡球 (BGA)



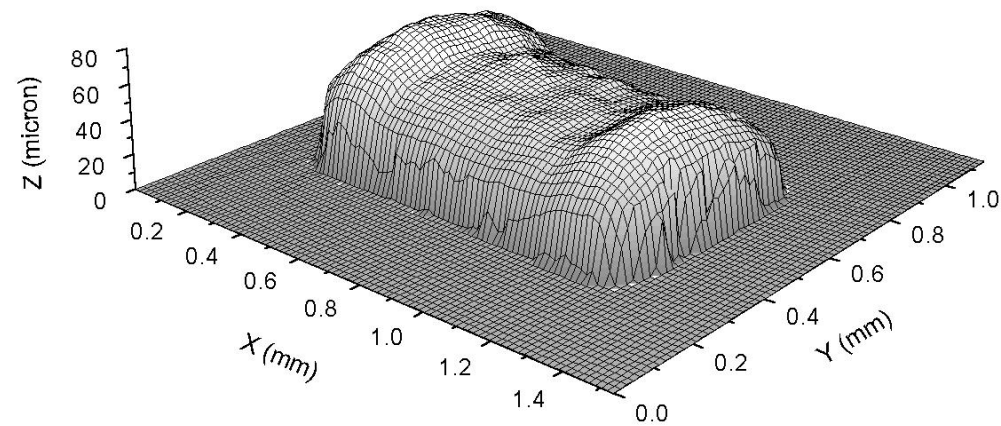
120° 表面翘曲变形



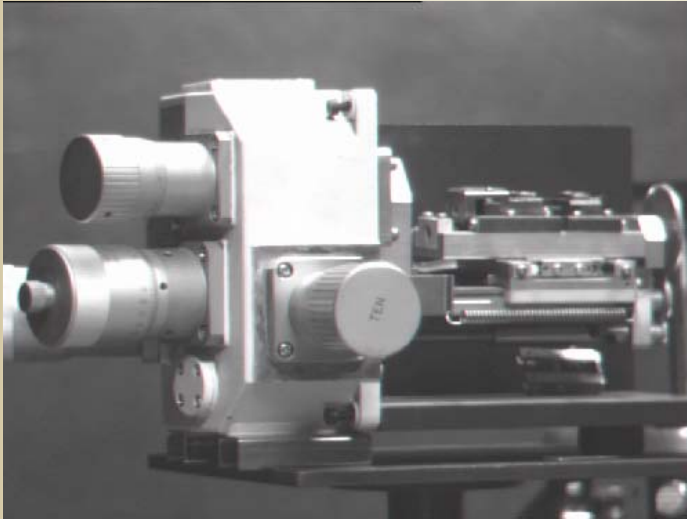
The photograph of a micro resistance



微结构三维形貌

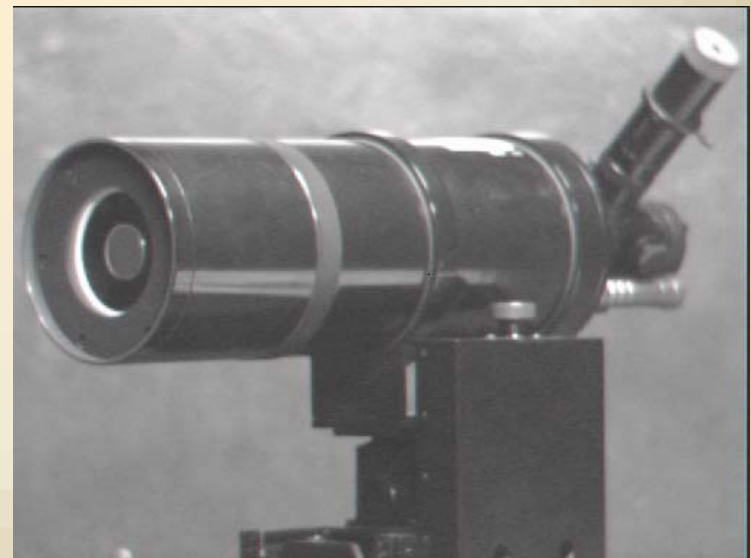


微结构测试装置



**Manual Control Loading
Stage for Small Specimen**

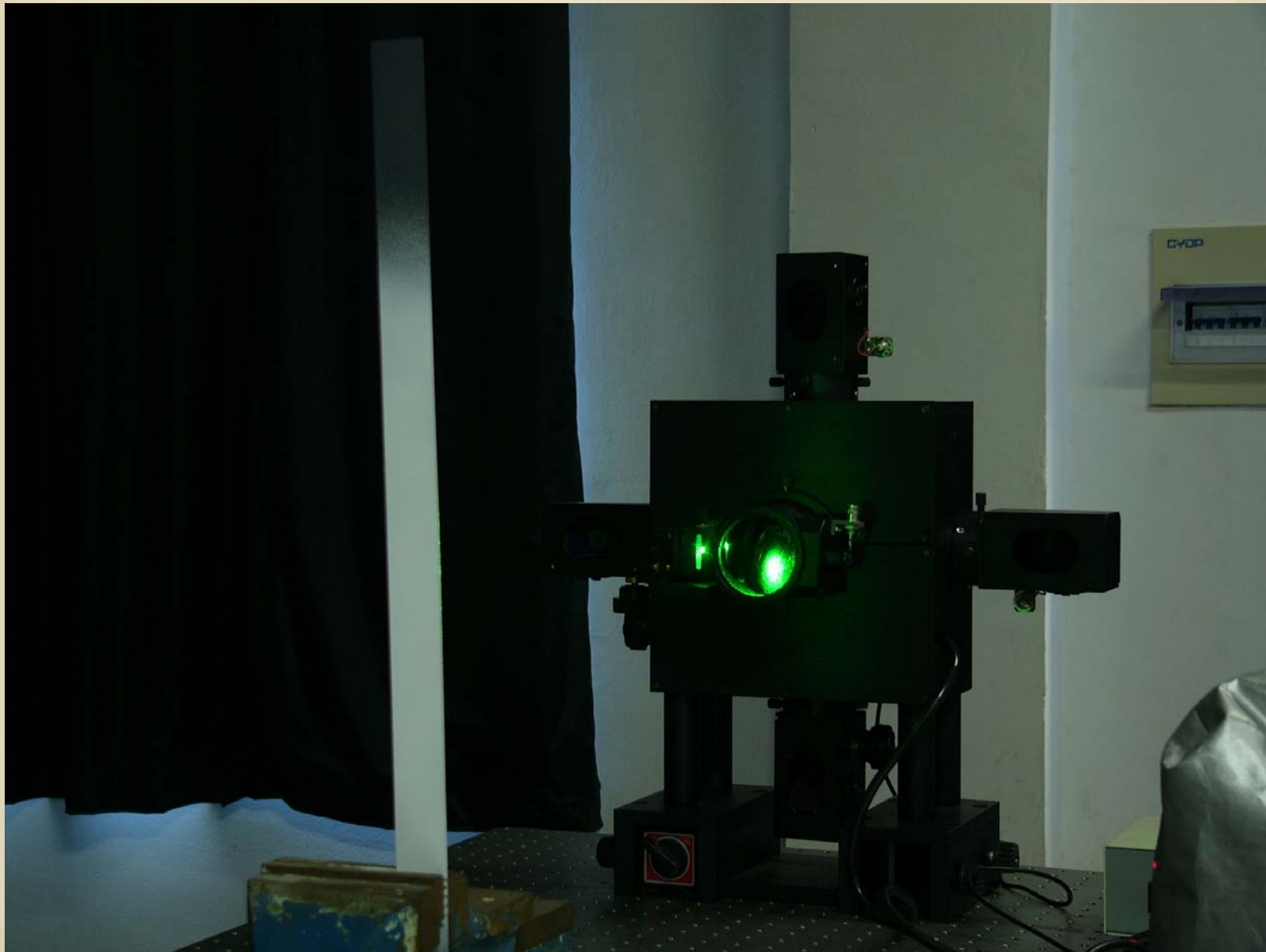
**Long Working Distance
Microscope**



Tensile strain measurement
of small samples using
digital correlation technique

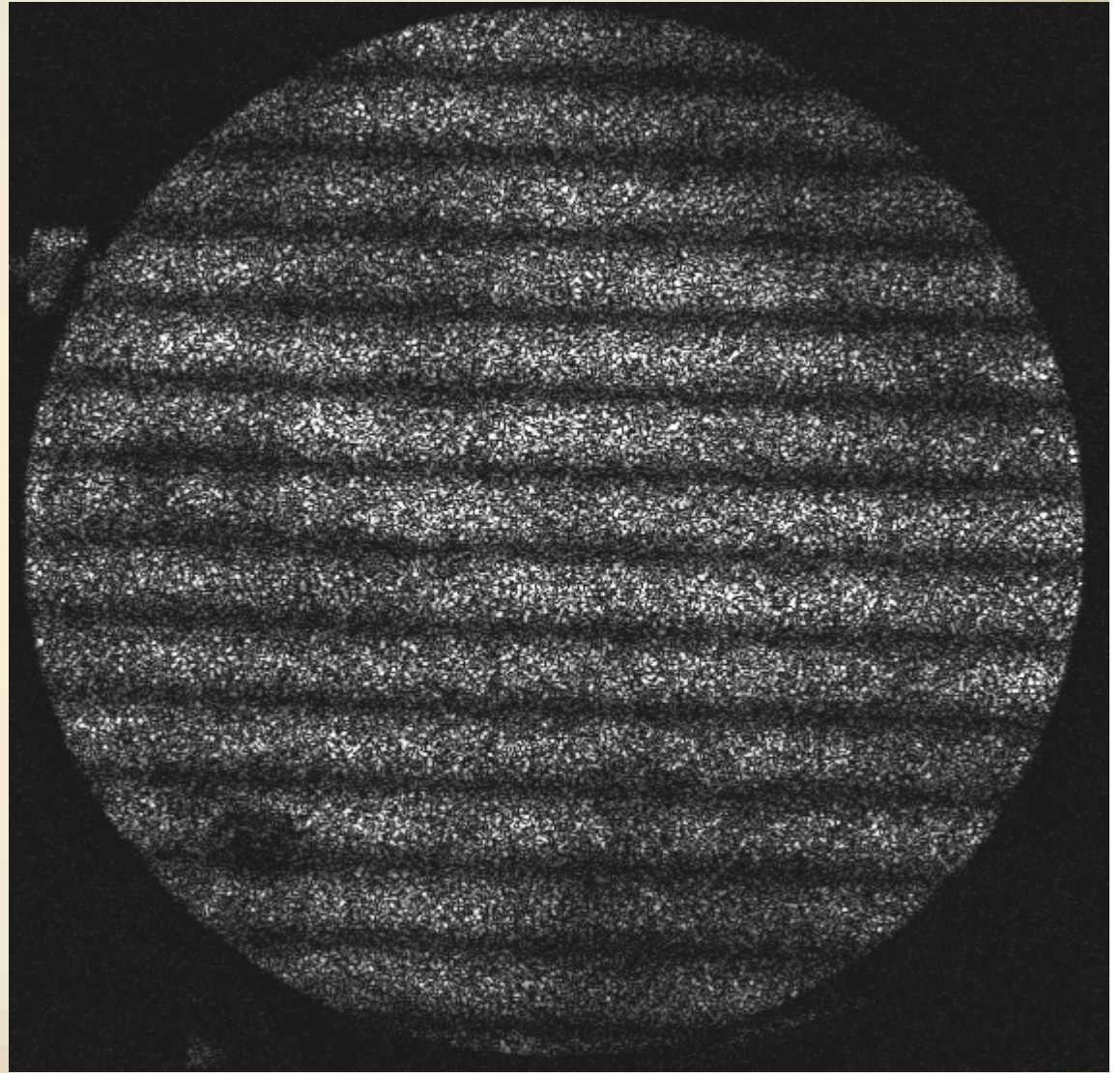
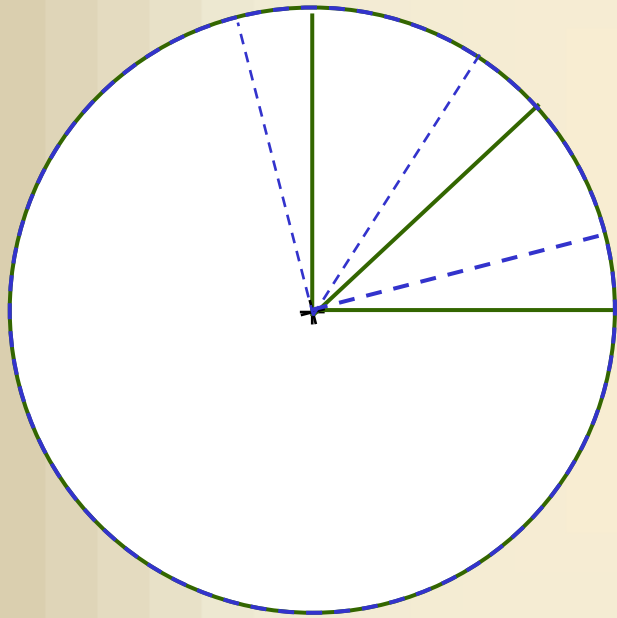
散斑干涉法

散斑干涉法



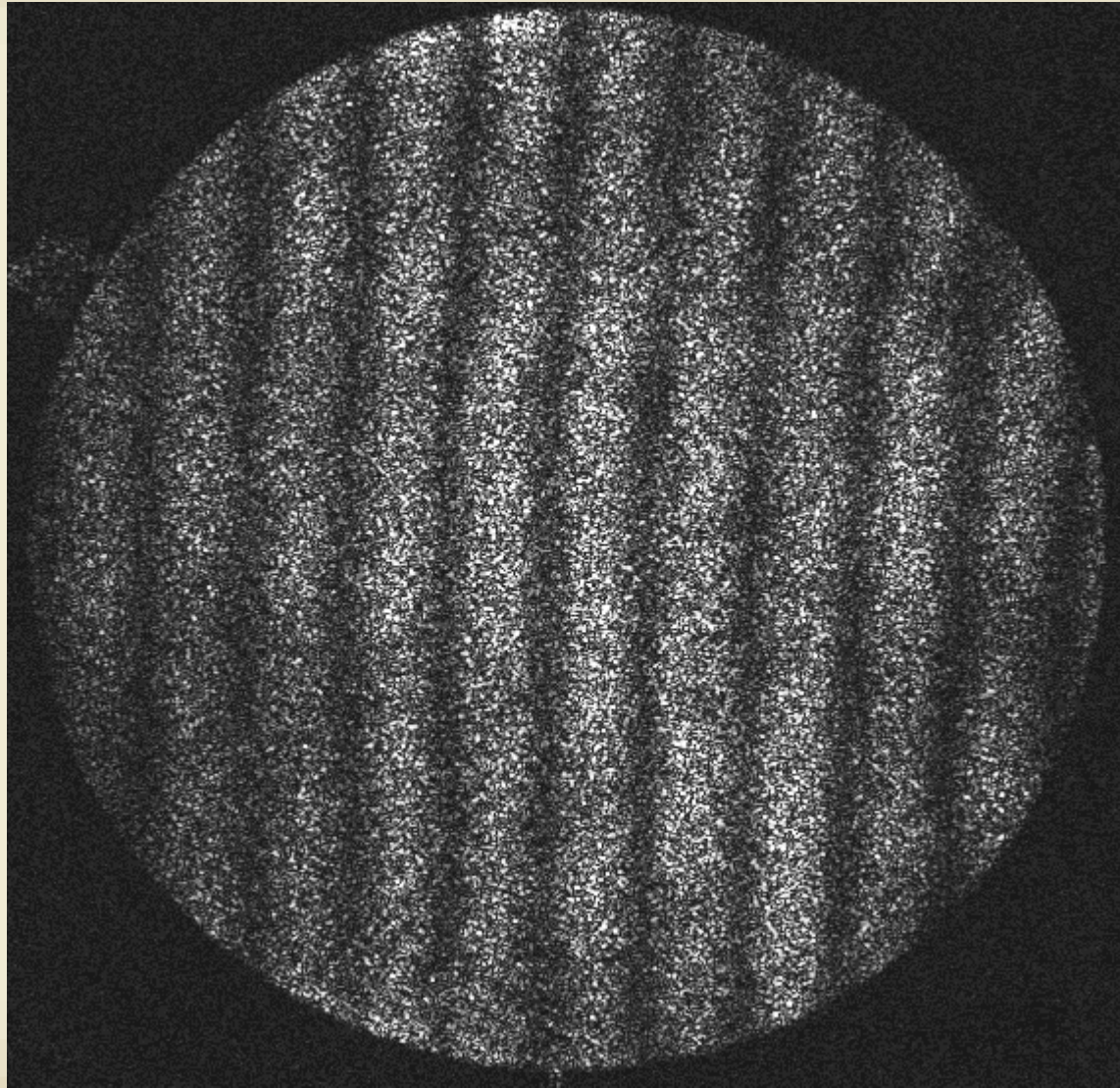
U 场

散斑法

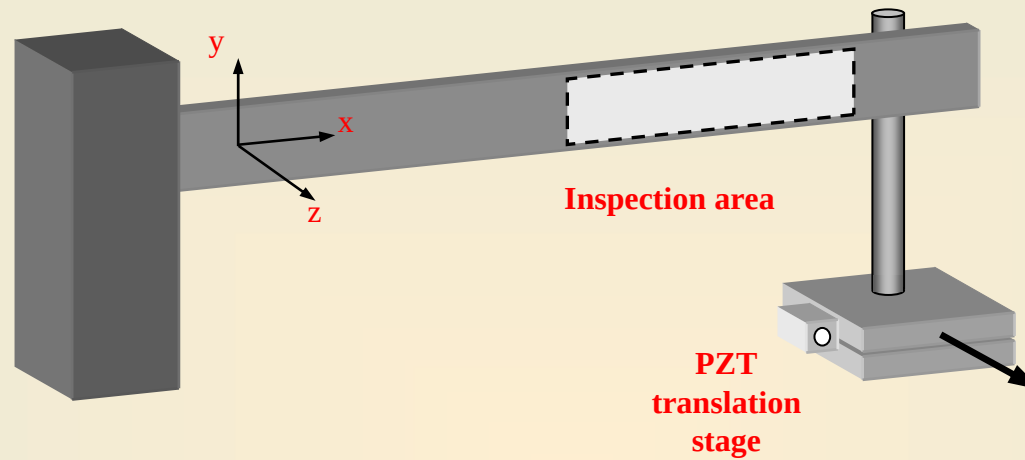


V 场

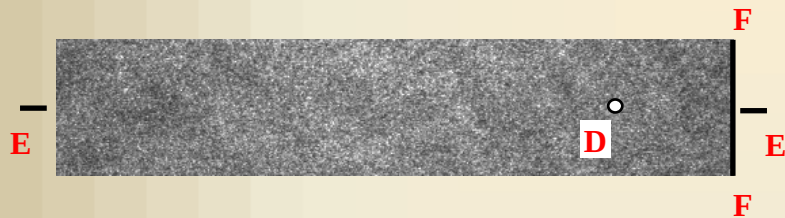
散斑法



Specimen 2: A cantilever beam:



Typical speckle pattern:

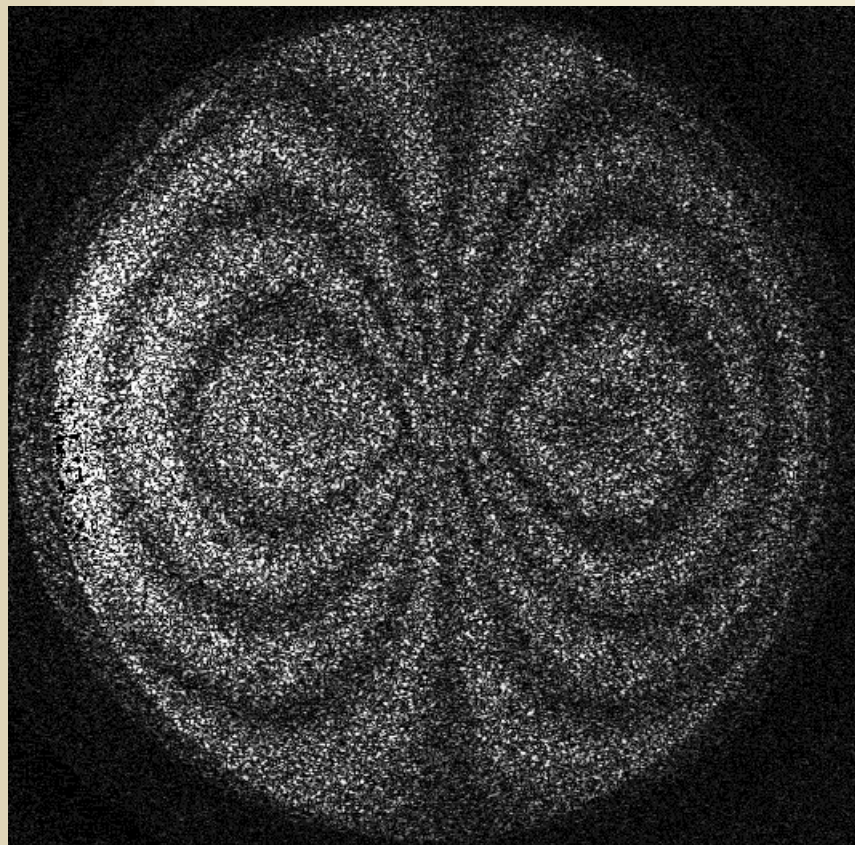


ESPI fringe patterns:

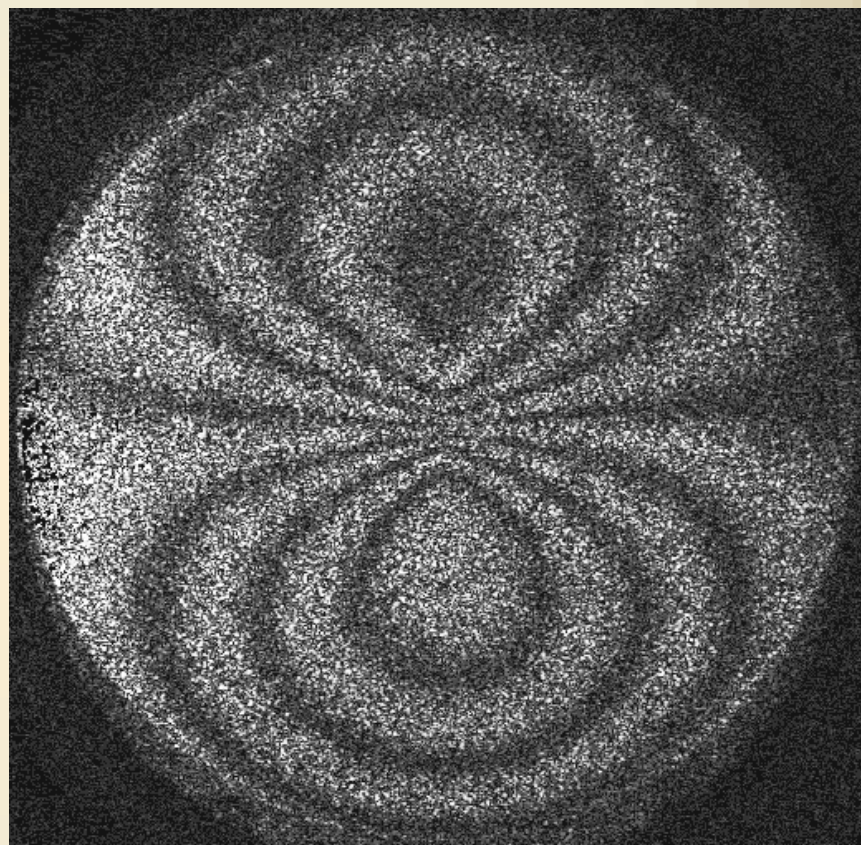


- Capturing rate: 250 frame/second

剪切电子散斑干涉测量结果

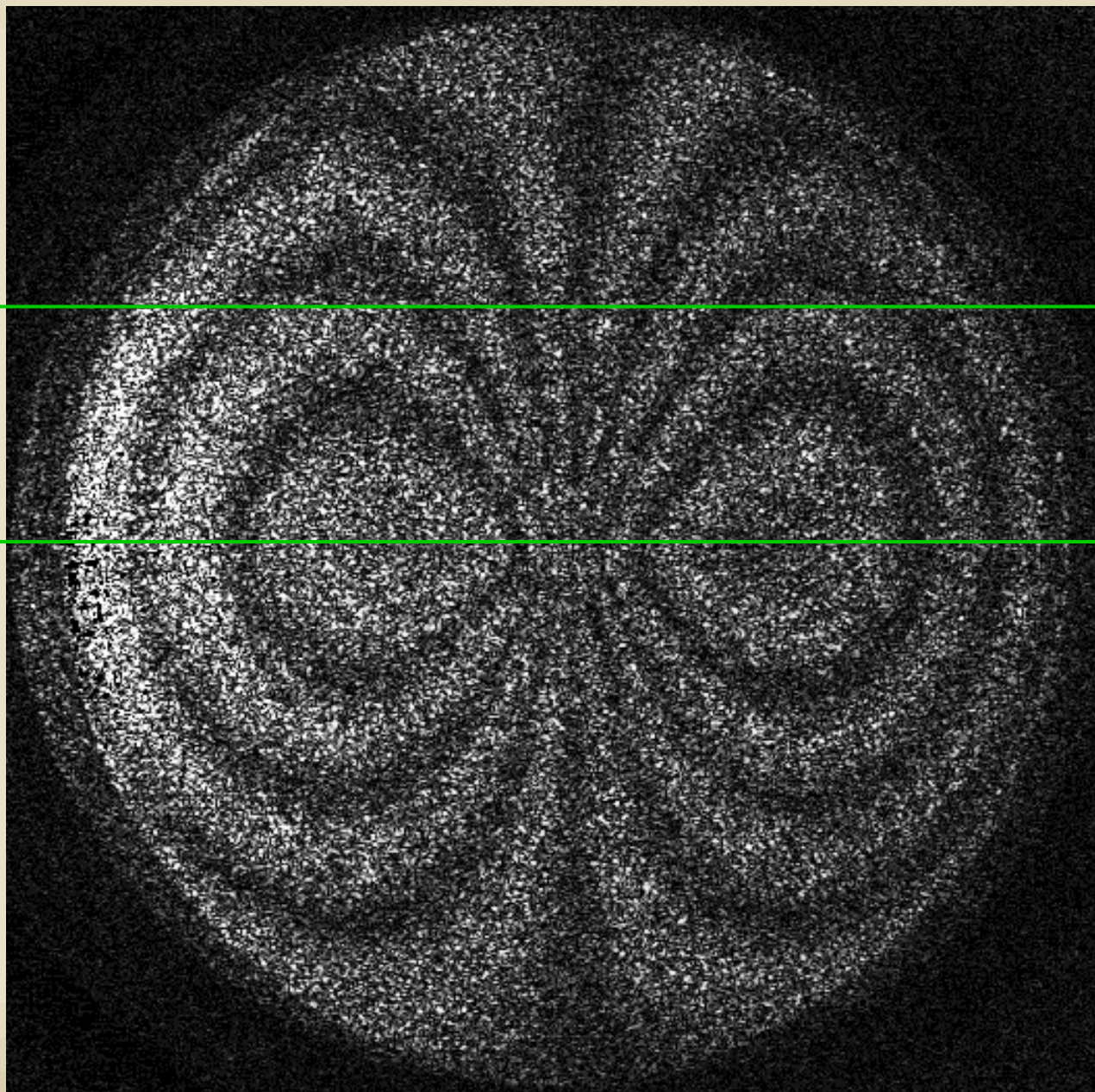


错位 $\frac{\partial w}{\partial x}$



错位 $\frac{\partial w}{\partial y}$

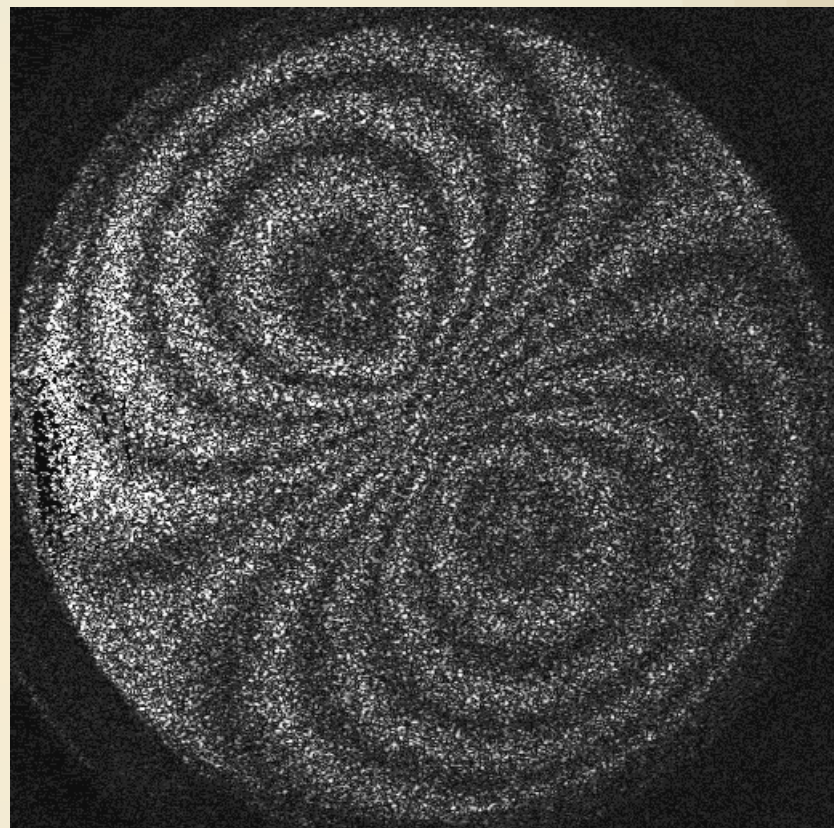
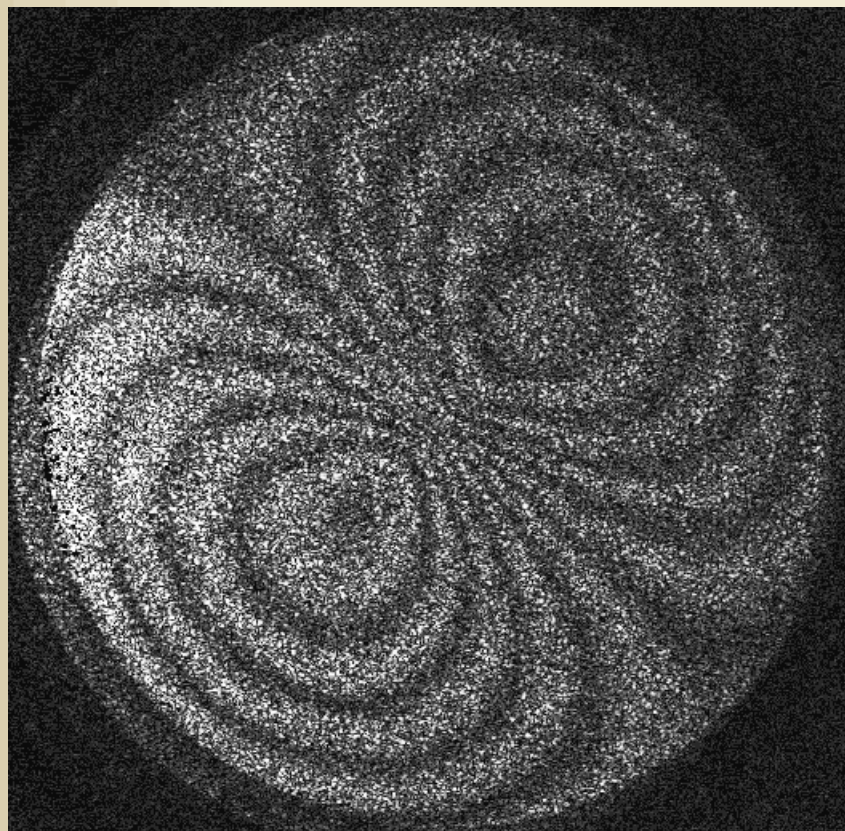
剪切散斑干涉法



错位

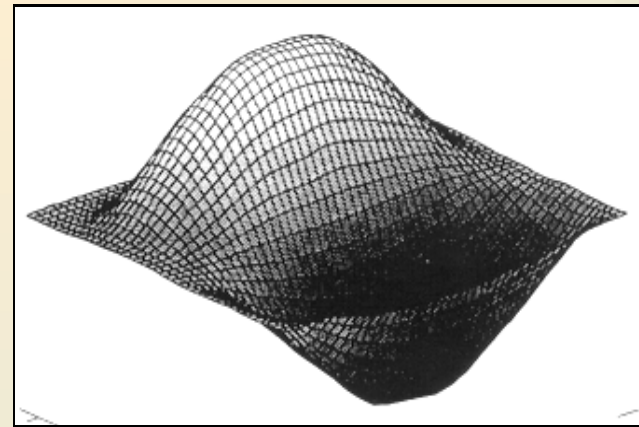
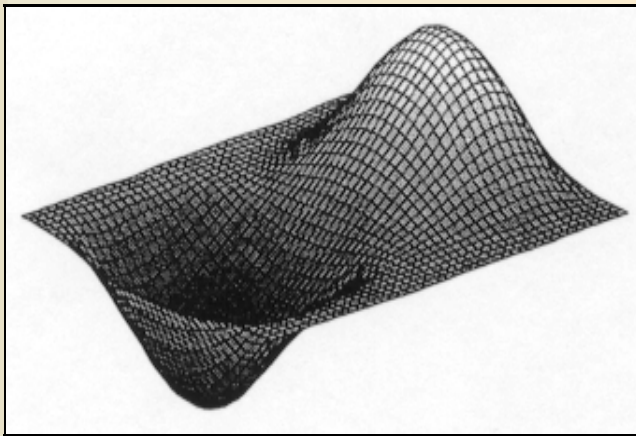
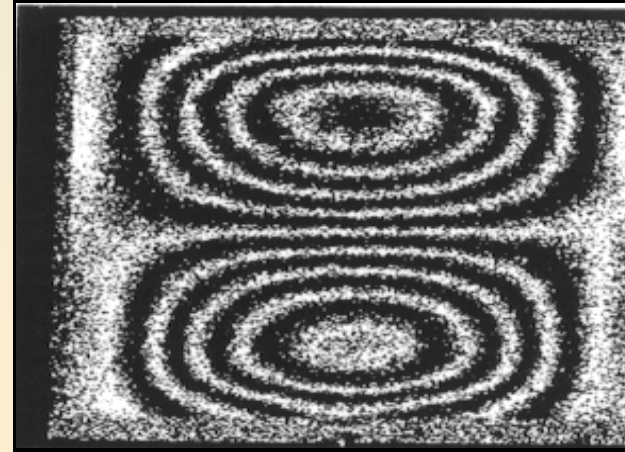
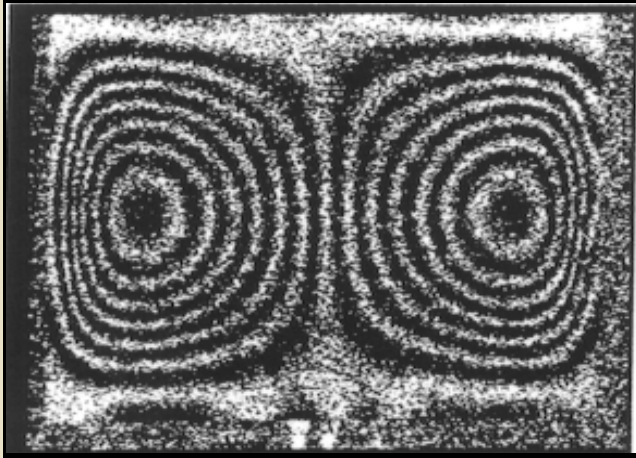
$$\frac{\partial w}{\partial x}$$

剪切电子散斑干涉测量结果

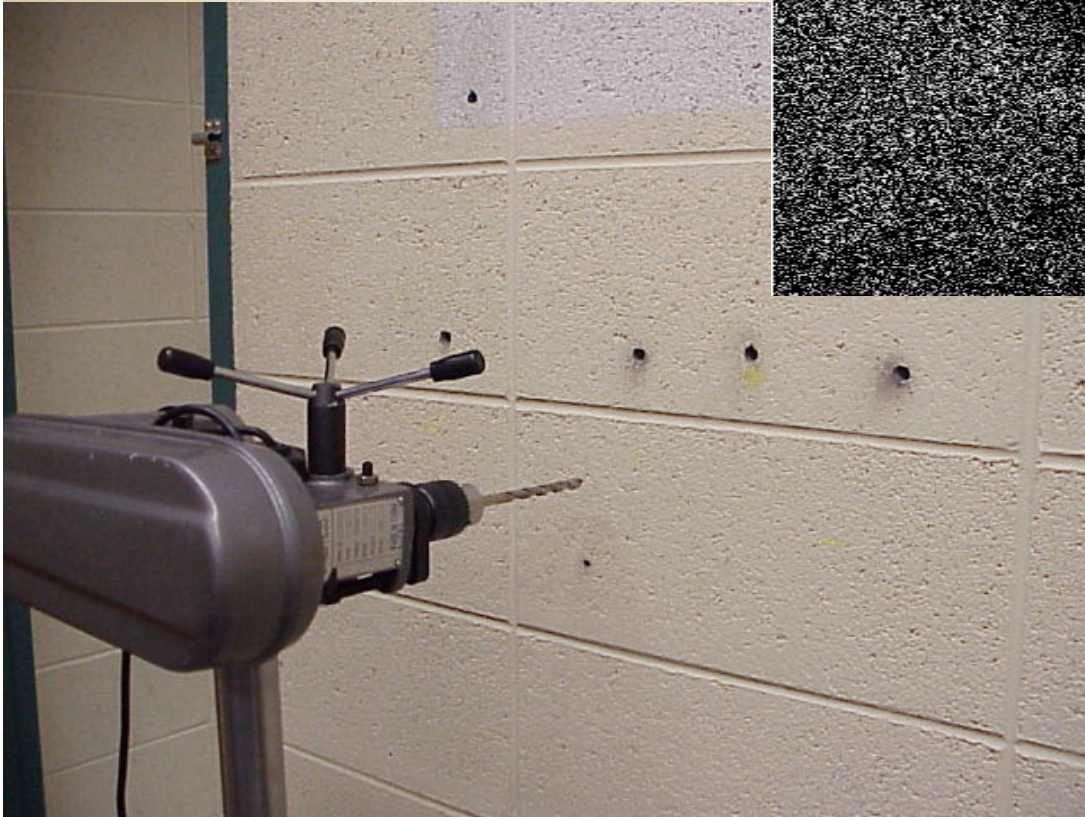
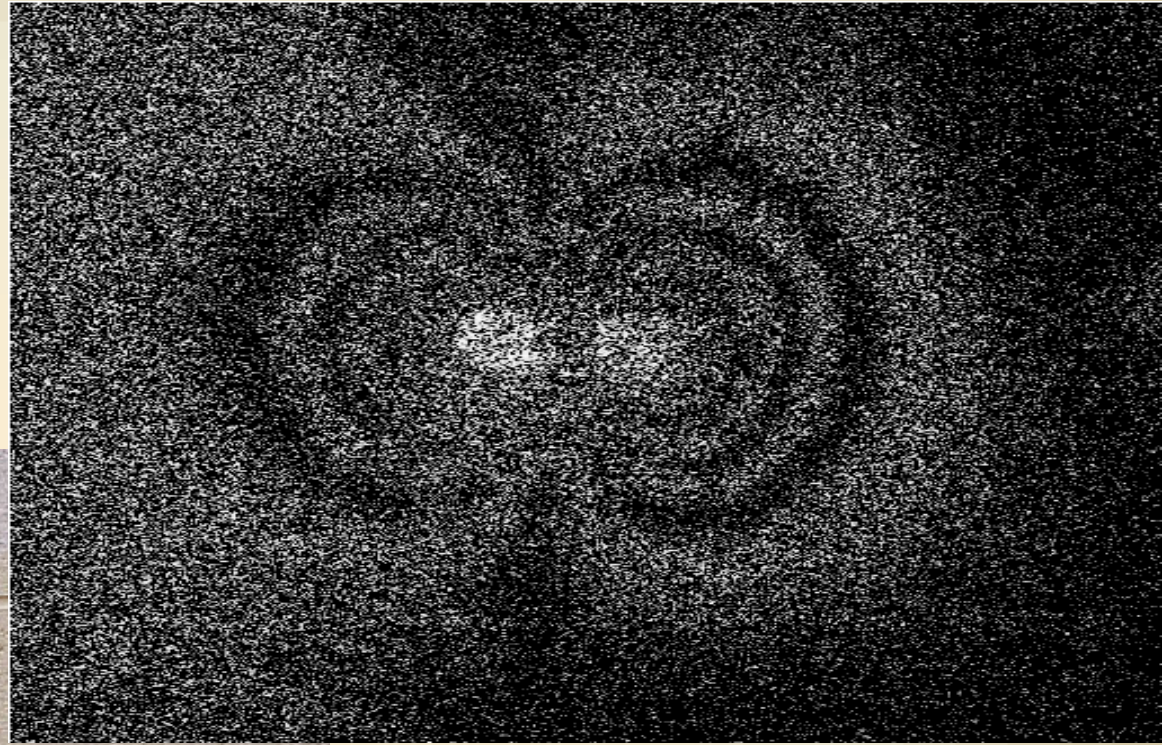


$\pm 45^\circ$ 方向错位

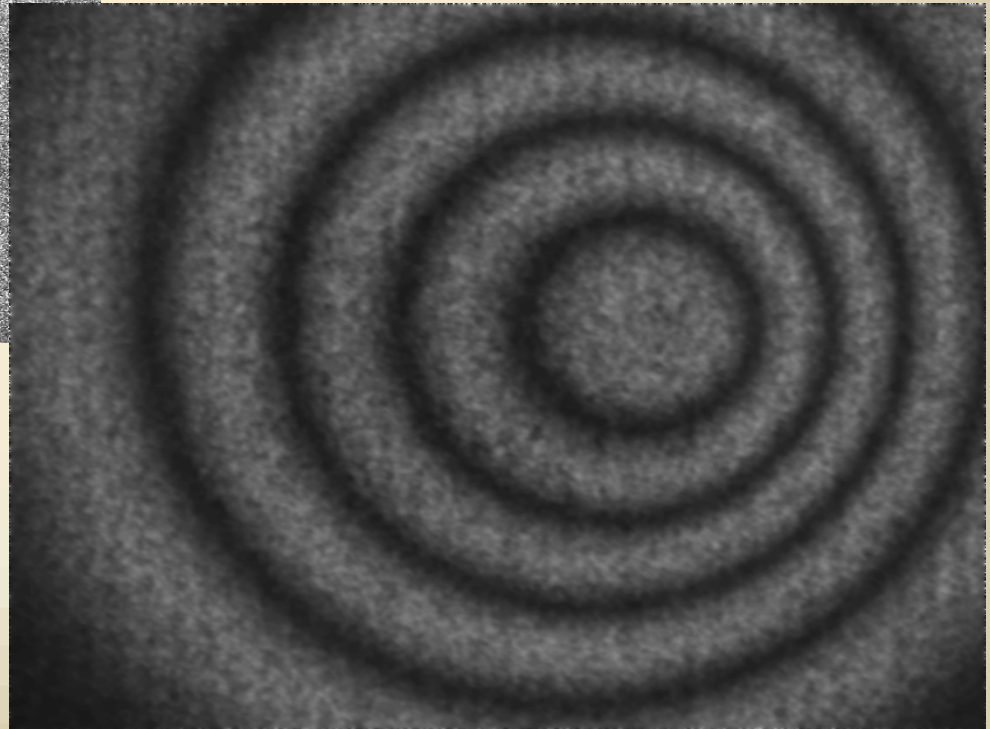
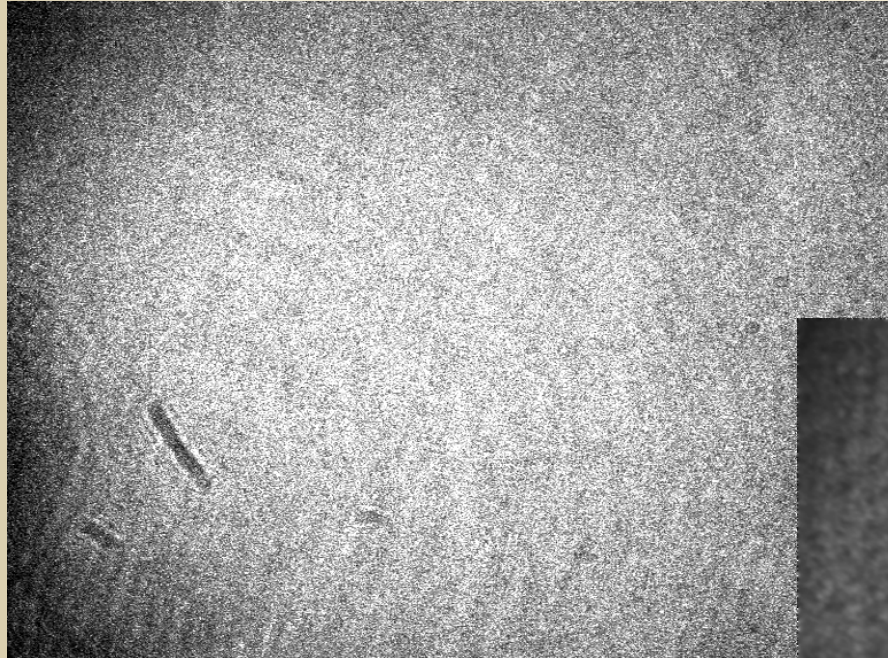
剪切 (Shearography)



剪切 (Shearography)



圆板受集中载荷

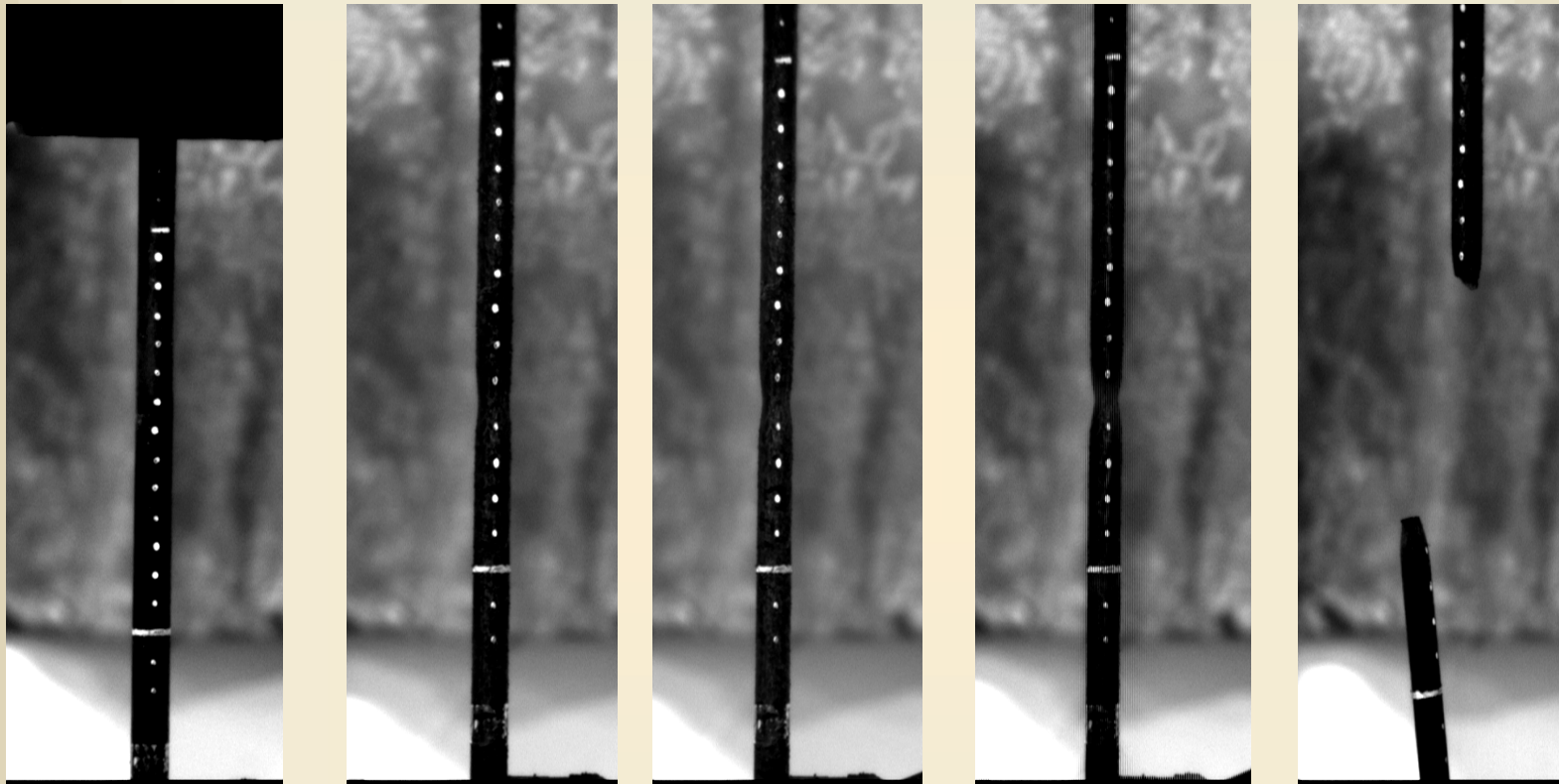


图像相关法

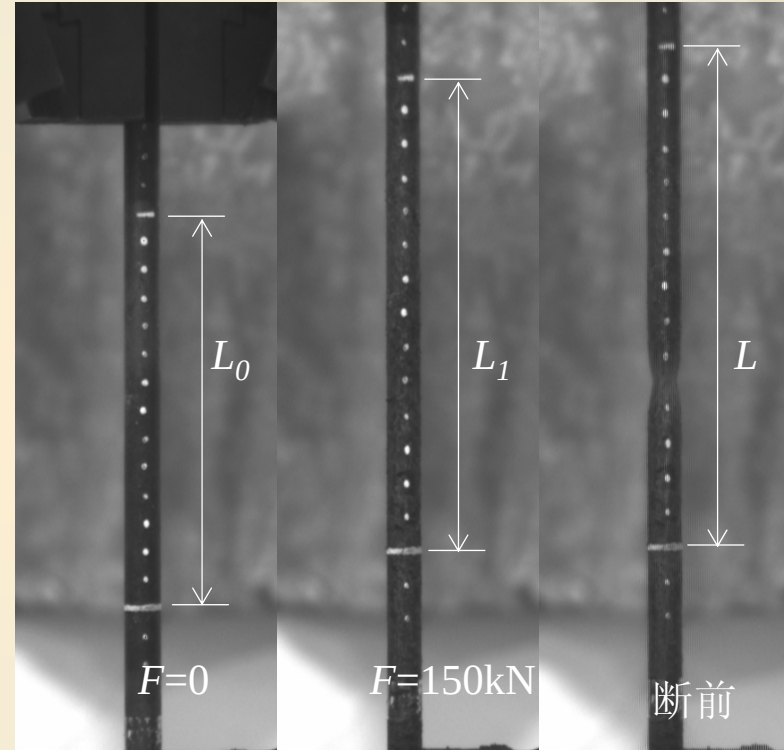
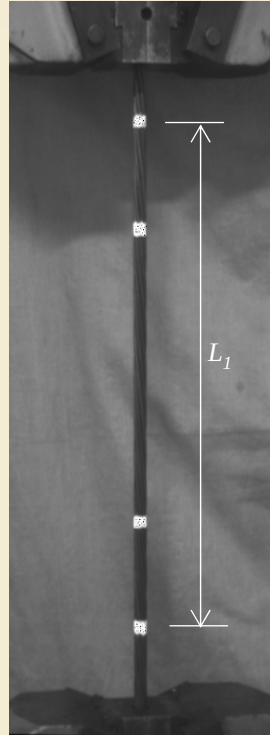
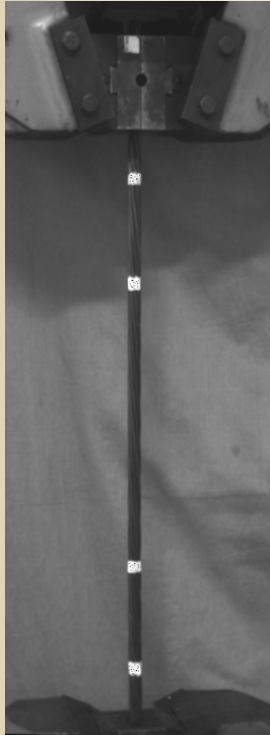
图像相关法



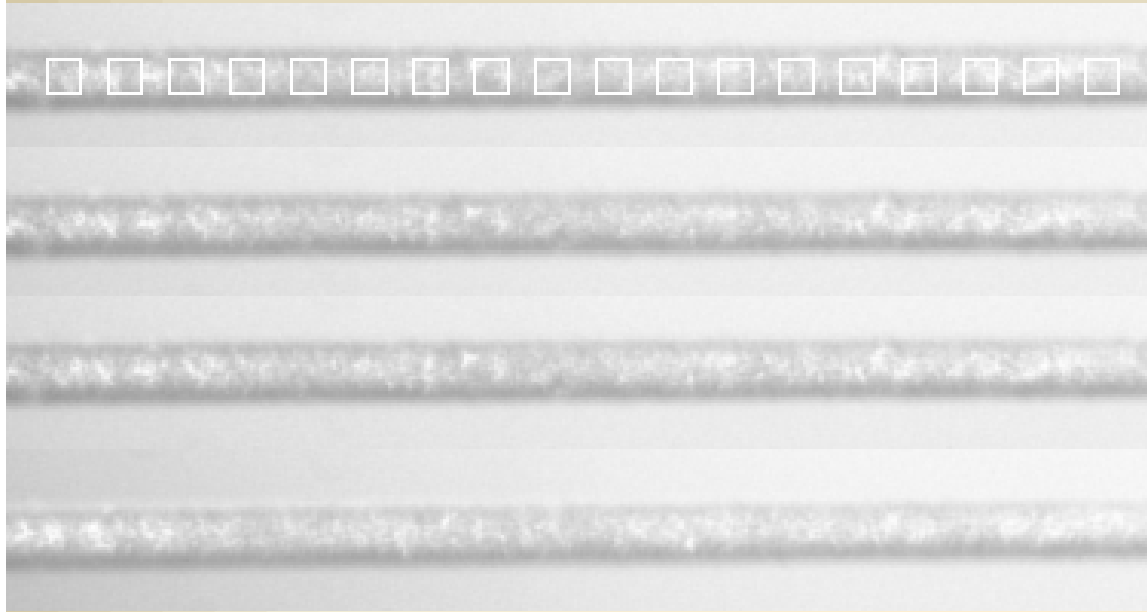
图像相关法



图像相关法



微结构材料特性测试

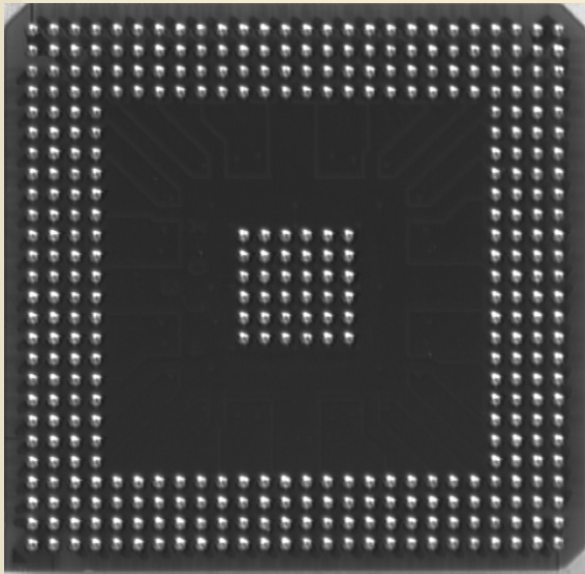


Specimen No.	Young's Modulus E (GPa)	Difference between experiment and theory (%)
1	189	0.5
2	187	1.6
3	188	1.1
4	191	0.5

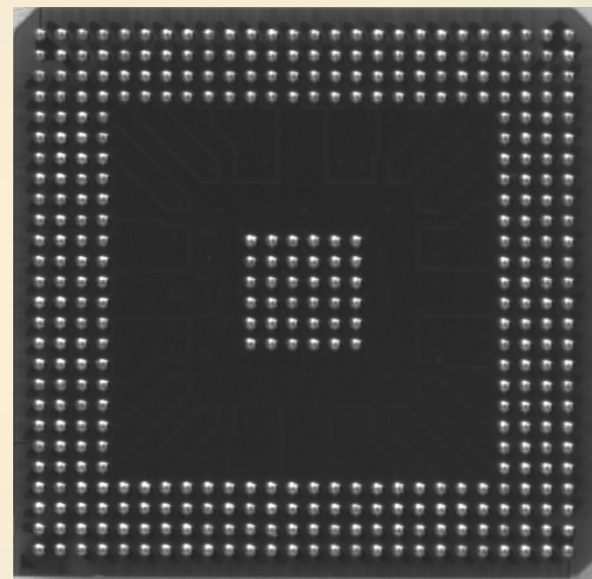
三维测量



The Images of a BGA From the Right and Left Cameras

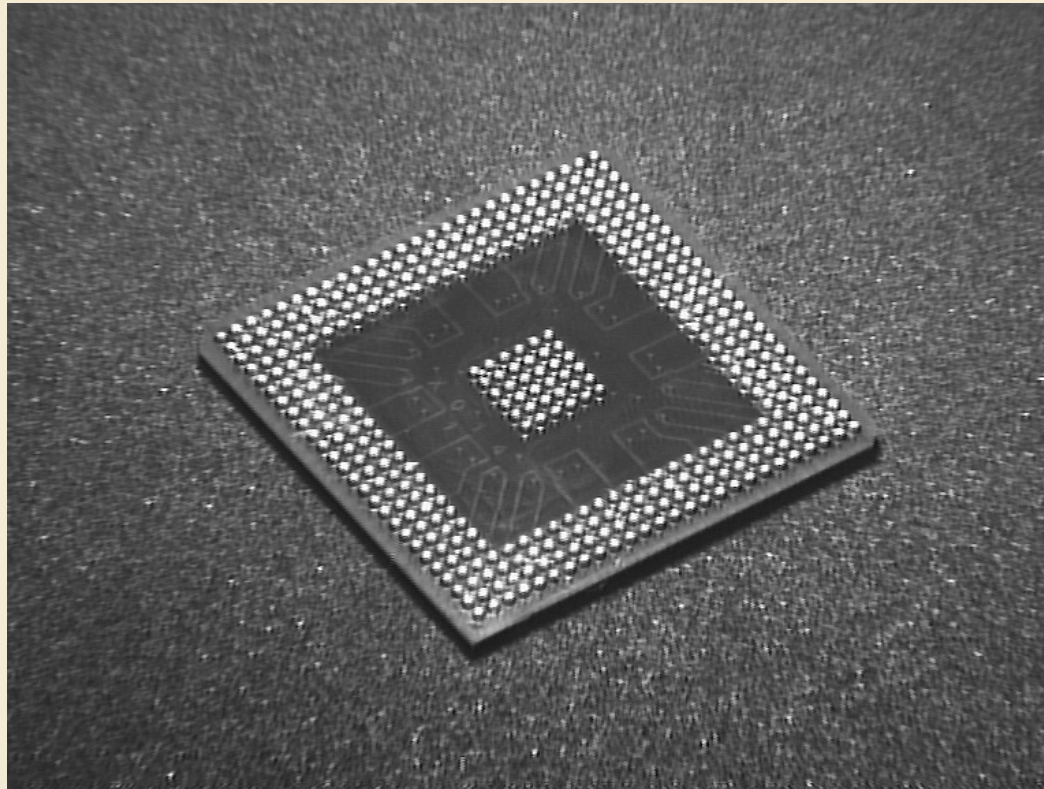


left

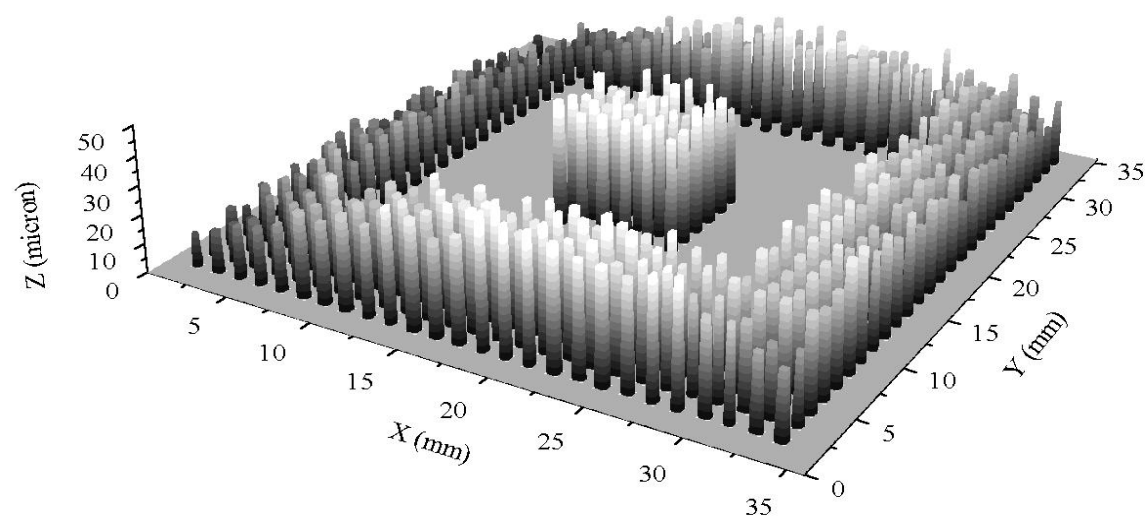


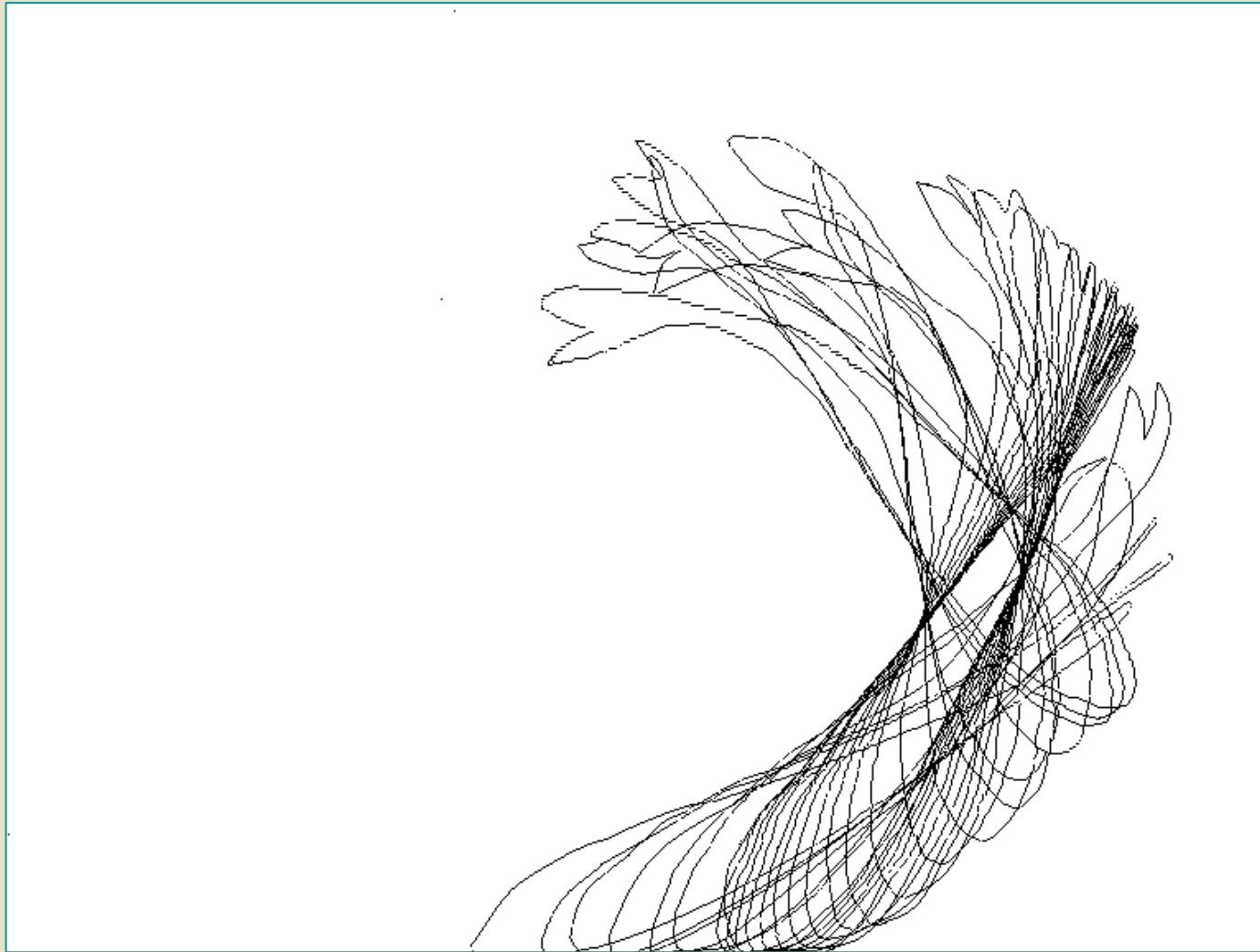
right

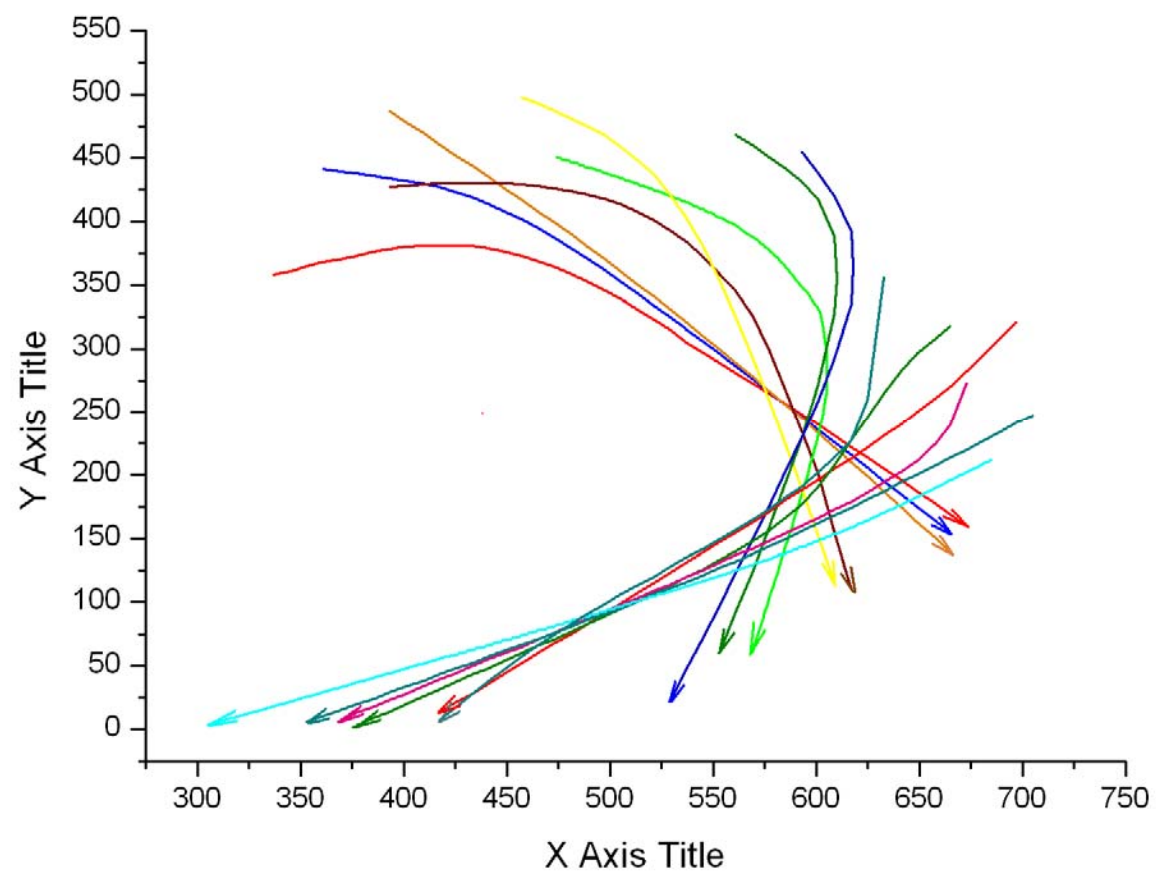
Coplanarity Study on Ball Grid Array Packaging

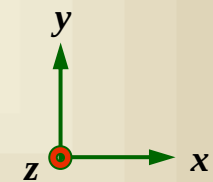
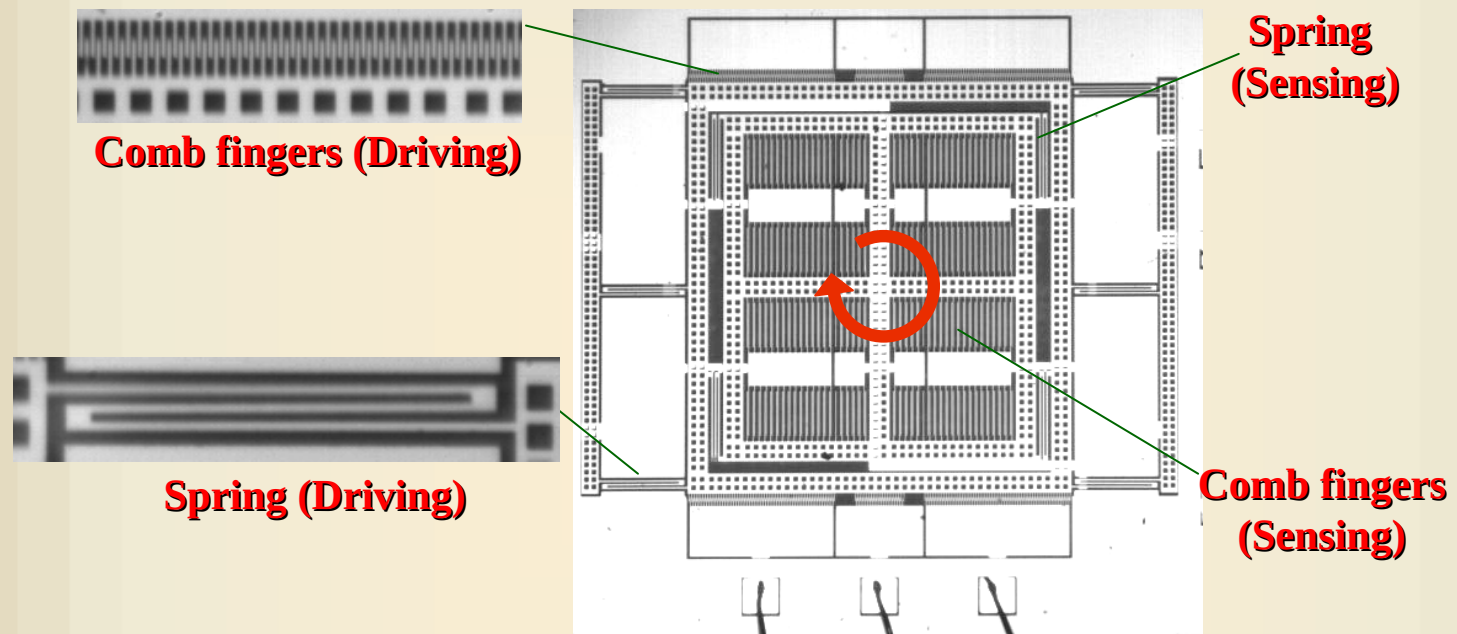


焊锡球表面三维形貌

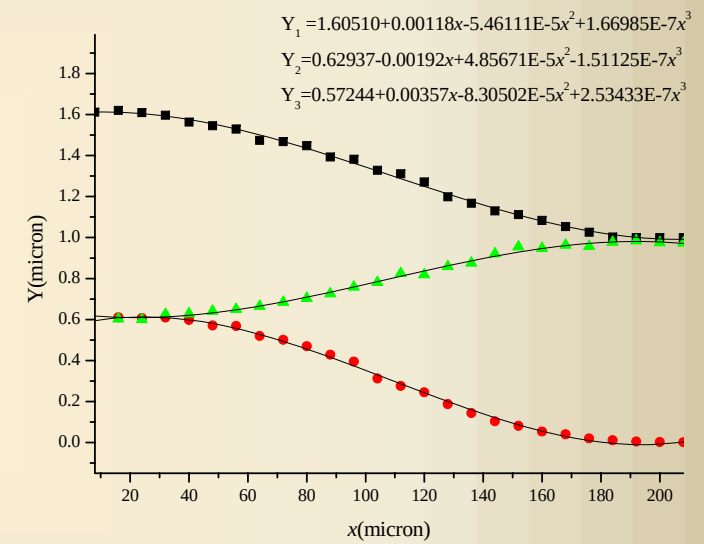


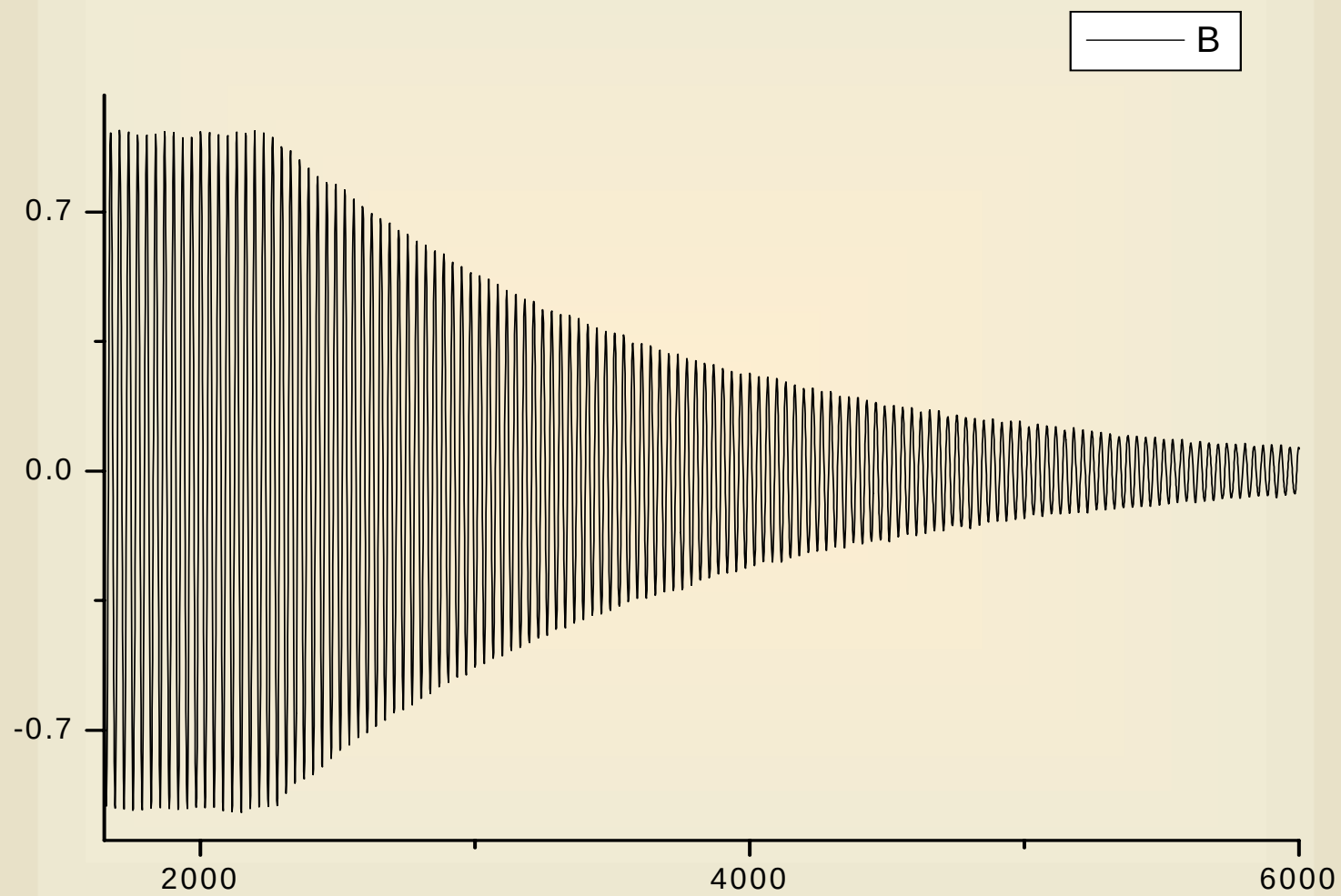


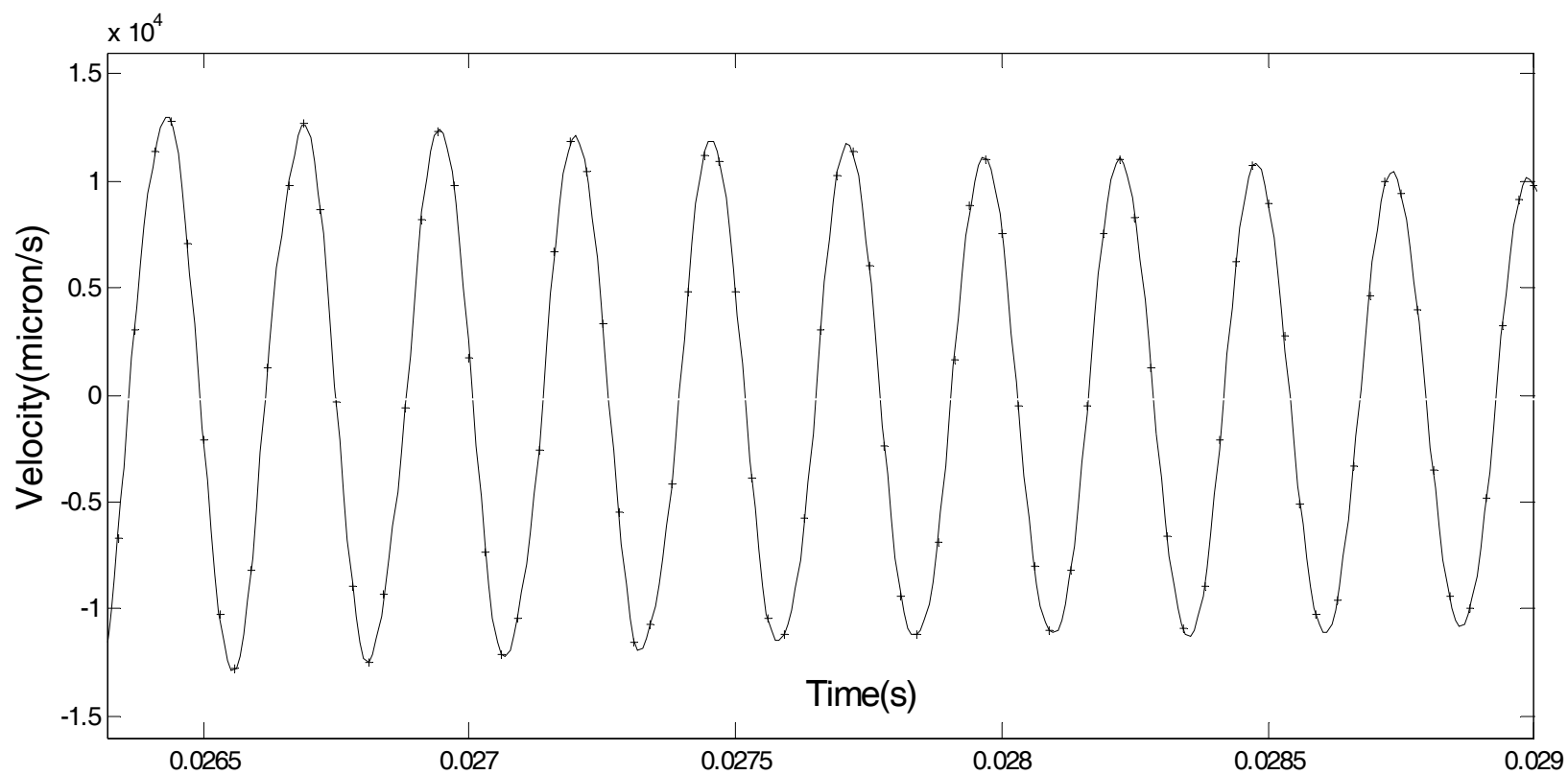




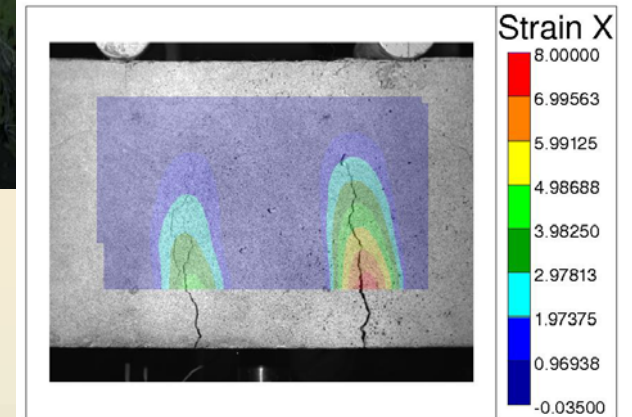
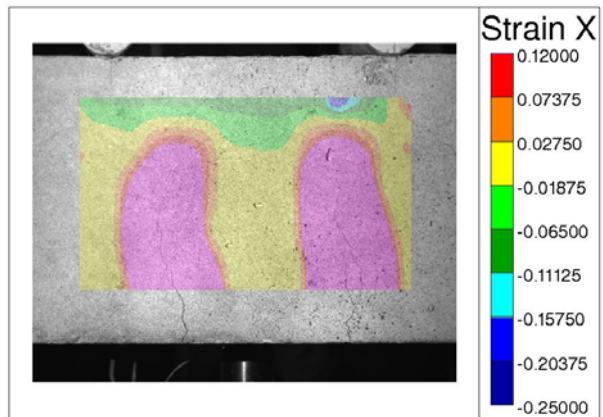
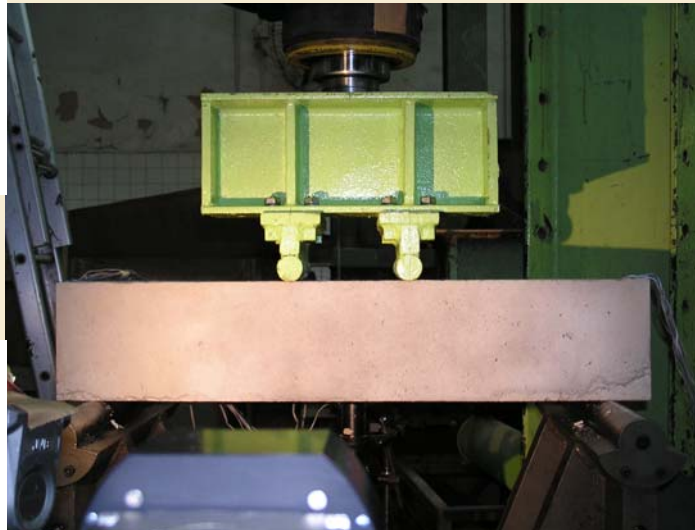
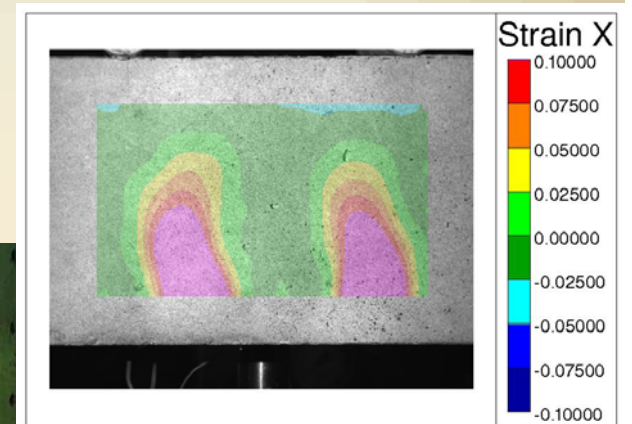
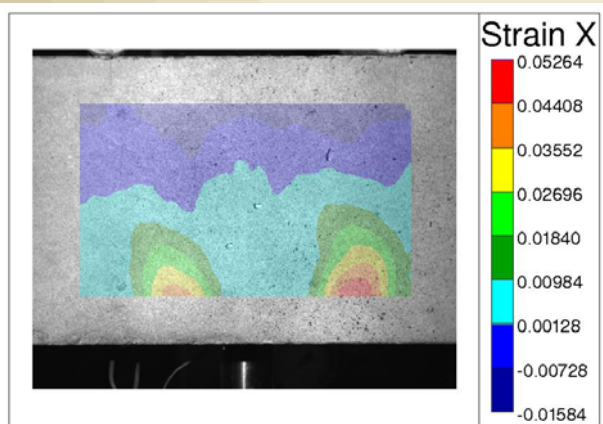
光学测振







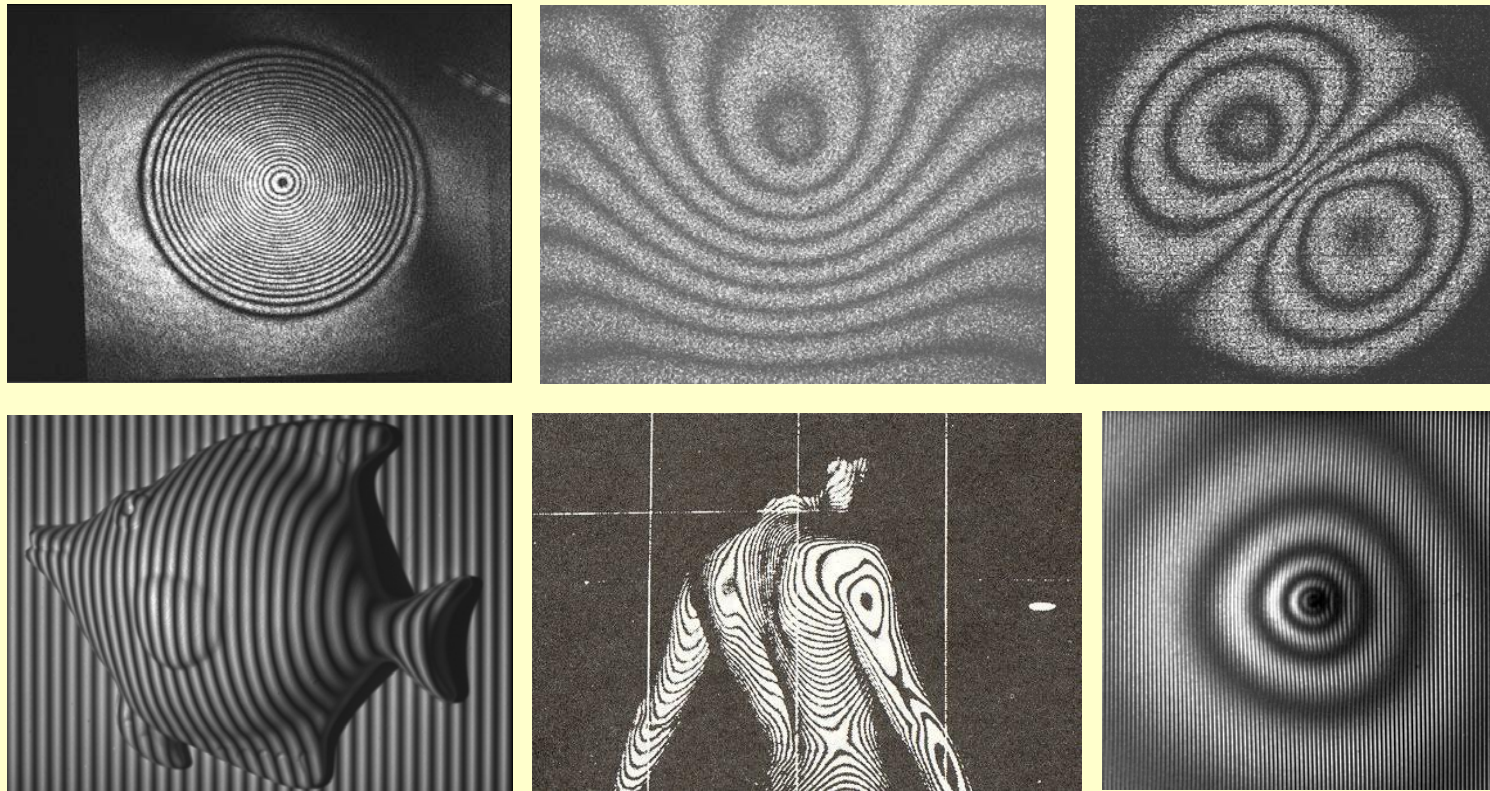
混凝土表面全场变形测量



➤ Phase Measurement Techniques

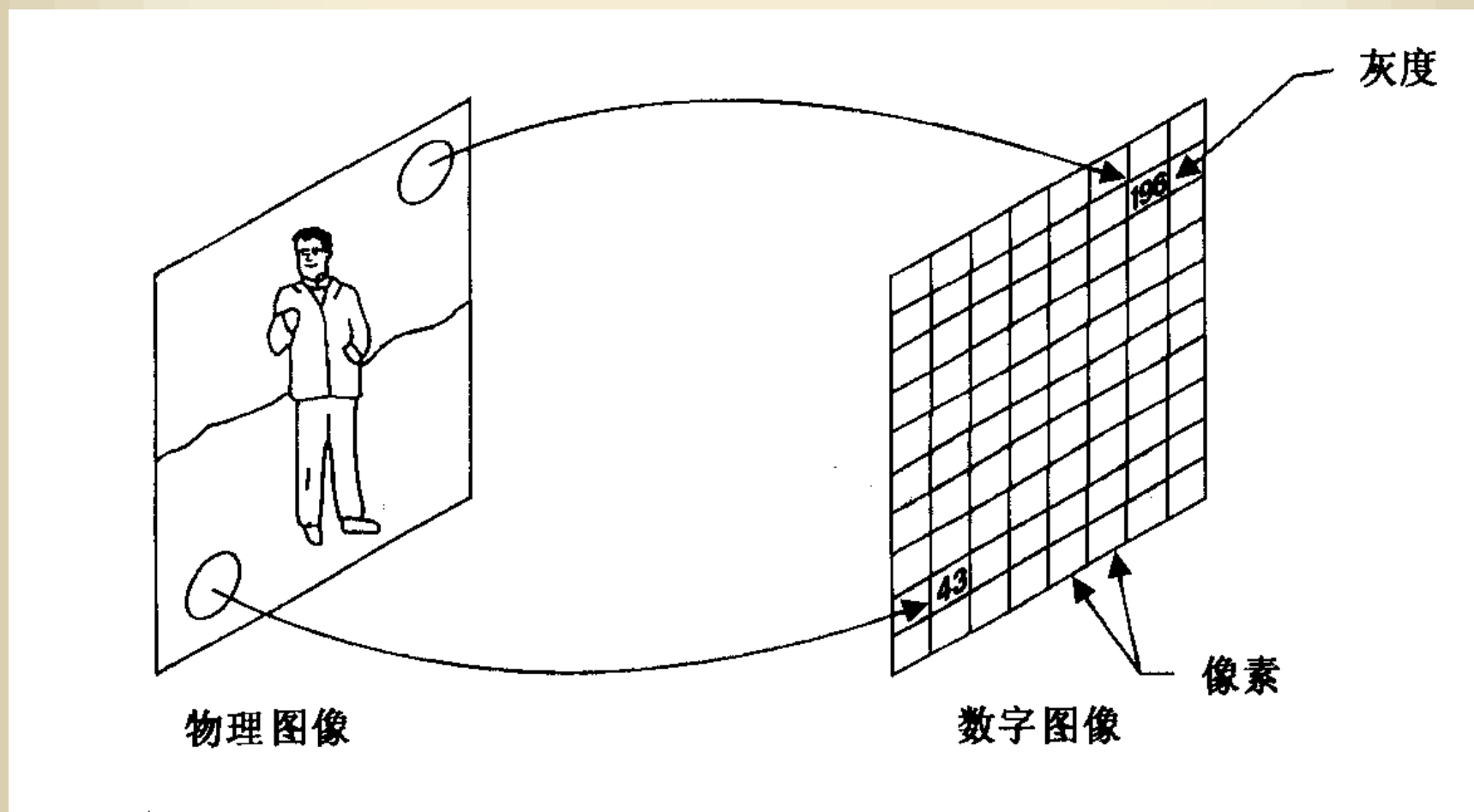
- Data Recording

Holography, ESPI, Shearography, Fringe projection, Moiré ...



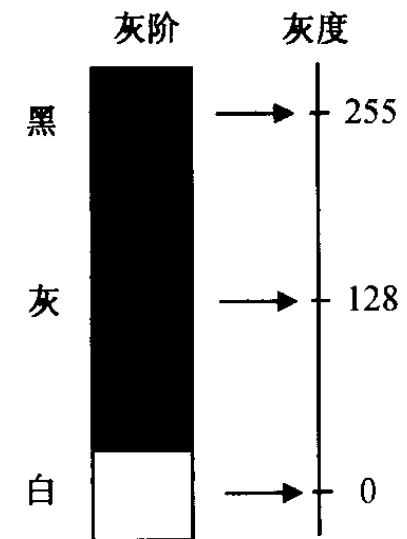
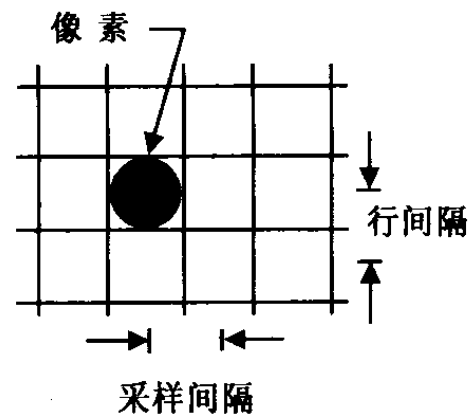
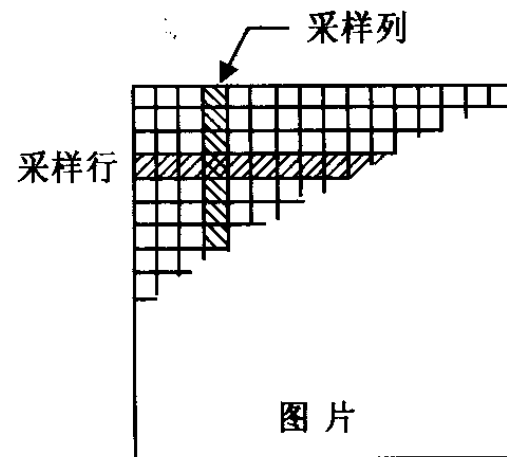
图像数字化

在其自然的形式下，图像并不能直接由计算机进行分析，因为计算机只能处理数字而不是图片，所以一幅图像在用计算机进行处理前必须先转化为数字形式。



像素的两个属性:

位置 灰度



CCD成像原理

CCD (Charge Coupled Device)，中文名字叫电荷耦合器，是一种特殊的半导体材料。它由大量独立的光敏元件组成，这些光敏元件通常是按矩阵排列的。光线透过镜头照射到**CCD**上，并被转换成电荷，每个元件上的电荷量取决于它所受到的光照强度。当你按动快门，**CCD**将各个元件的信息传送到模/数转换器 (图像卡)上，模拟电信号经过模/数转换器处理后变成数字信号，数字信号以一定格式压缩后存入缓存内，此时一张数码照片诞生了。然后图像数据根据不同的需要以数字信号和视频信号的方式输出。

- 光测力学教程 赵清澄 主编 高等教育出版社 1996. 12 52. 581/9
- 光测力学 阮孟光 等编 北京航空航天大学出版社 1995 52. 581/8
- 简明实验力学 王 峰 等编著 科学出版社 1993. 10 52. 58/10
- 实验力学基础 宋逸先 著主编 水利电力出版社 1992 52. 5/13
- 现代光测力学 戴福隆 等编著 科学出版社 1990 52. 581/5
- 实验应力分析 (美)J. W. 达利, W. F. 赖利著 海洋出版社 1987 52. 58/8
- 8. 实验应力分析 张如一, 陆耀楨主编 机械工业出版社 1981 52. 58/3
- 9. 实验应力分析的若干问题及方法 庄德恩编著 科学出版社 1979 73. 15/2



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