

Experiment

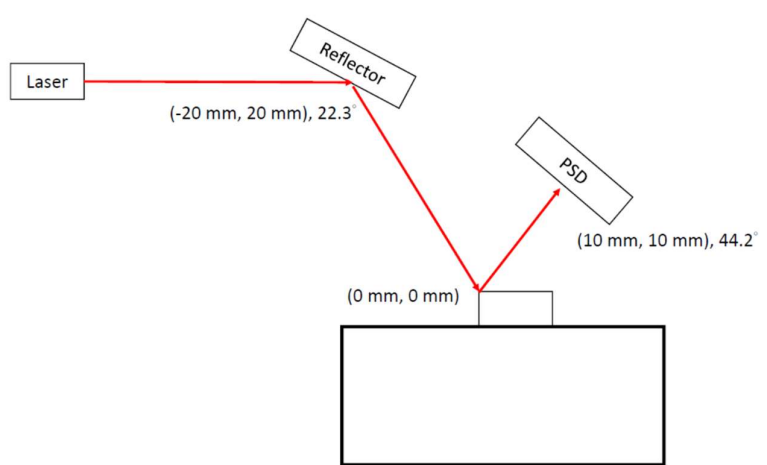


A1-1

中文 (Official)

Elasticity of cantilever Part A. Alignment of light path

A1. 0.6 pt



The diagram shows a coordinate system with the origin at (0 mm, 0 mm). A Laser is located at (-20 mm, 20 mm) and emits a red beam towards the origin. The angle of the beam is 22.3°. A Reflector is positioned at the origin (0 mm, 0 mm). A PSD (Position Sensitive Detector) is located at (10 mm, 10 mm) and receives the reflected beam. The angle of the beam at the PSD is 44.2°. A cantilever is shown below the origin, represented by a rectangular block.

A2. 0.8 pt

time (s)	position d (m)	time (s)	position d (m)	time (s)	position d (m)
3	-6.415×10^{-4}	48	1.198×10^{-4}	93	6.85×10^{-5}
6	5.261×10^{-4}	51	-4.46×10^{-5}	96	7.36×10^{-5}
9	4.843×10^{-4}	54	1.488×10^{-4}	99	8.73×10^{-5}
12	3.349×10^{-4}	57	-7.70×10^{-5}	102	7.93×10^{-5}
15	-5.386×10^{-4}	60	8.75×10^{-5}	105	6.39×10^{-5}
18	7.91×10^{-5}	63	1.604×10^{-4}	108	3.22×10^{-5}
21	-2.762×10^{-4}	66	-1.93×10^{-5}	111	6.05×10^{-5}
24	1.398×10^{-4}	69	1.159×10^{-4}	114	3.20×10^{-5}
27	-2.039×10^{-4}	72	7.10×10^{-5}	117	4.71×10^{-5}

Experiment



A1-2

中文 (Official)

30	-4.42×10^{-5}	75	3.6×10^{-6}	120	8.26×10^{-5}
33	-1.988×10^{-4}	78	-1.79×10^{-5}		
36	-2.77×10^{-5}	81	9.21×10^{-5}		
39	1.195×10^{-4}	84	6.00×10^{-5}		
42	1.960×10^{-4}	87	1.361×10^{-4}		
45	2.192×10^{-4}	90	5.72×10^{-5}		

A3.

1.0 pt

d (m)	\bar{d} (m)	$d - \bar{d}$ (m)	standard deviation
6.85×10^{-5}	6.267×10^{-5}	5.5×10^{-6}	1.88×10^{-5}
7.36×10^{-5}		1.09×10^{-5}	
8.73×10^{-5}		2.46×10^{-5}	
7.93×10^{-5}		1.66×10^{-5}	
6.39×10^{-5}		1.2×10^{-6}	
3.22×10^{-5}		-3.05×10^{-5}	
6.05×10^{-5}		-2.2×10^{-6}	
3.20×10^{-5}		-3.07×10^{-5}	
4.71×10^{-5}		-1.56×10^{-5}	
8.26×10^{-5}		1.99×10^{-5}	

reference value of measurement (with standard deviation) :

$$\underline{\underline{6.267 \times 10^{-5} \pm 1.88 \times 10^{-5} \text{ m}}}$$

Experiment



A1-3

中文 (Official)

Part B. Deformation of cantilever beam and deduction of Young's modulus

B1. answer sheet.

1.0 pt

F (N)	d (m)	$\bar{d} = d_0$ (m)
0	-1.82×10^{-5}	-1.386×10^{-5}
	-1.09×10^{-5}	
	-6.69×10^{-5}	
	1.72×10^{-5}	
	9.5×10^{-6}	

F (N)	$d - d_0 = \Delta d$ (m)	$\bar{\Delta d}$ (m)
2.00×10^{-9}	1.9136×10^{-4}	2.0046×10^{-4}
	2.0016×10^{-4}	
	1.9766×10^{-4}	
	2.0096×10^{-4}	
	2.1216×10^{-4}	
4.00×10^{-9}	4.2336×10^{-4}	4.2018×10^{-4}
	4.1536×10^{-4}	
	4.3526×10^{-4}	
	4.0346×10^{-4}	
	4.2346×10^{-4}	
6.00×10^{-9}	6.4136×10^{-4}	6.3112×10^{-4}
	6.4646×10^{-4}	
	6.4256×10^{-4}	
	6.2186×10^{-4}	
	6.0336×10^{-4}	
8.00×10^{-9}	7.1906×10^{-4}	7.7770×10^{-4}
	7.8006×10^{-4}	
	8.0506×10^{-4}	
	7.7736×10^{-4}	
	8.0696×10^{-4}	

Experiment



A1-4

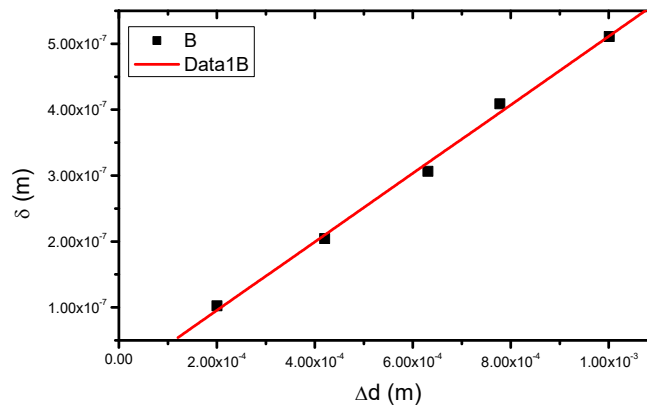
中文 (Official)

1.000×10^{-8}	1.01216×10^{-3}	1.00106×10^{-3}
	1.00076×10^{-3}	
	1.00336×10^{-3}	
	9.7846×10^{-4}	
	1.01076×10^{-3}	

B2.

1.0 pt

F (N)	δ (m)	$\overline{\Delta d}$ (m)
2.00×10^{-9}	1.022×10^{-7}	2.0046×10^{-4}
4.00×10^{-9}	2.044×10^{-7}	4.2018×10^{-4}
6.00×10^{-9}	3.066×10^{-7}	6.3112×10^{-4}
8.00×10^{-9}	4.088×10^{-7}	7.7770×10^{-4}
1.000×10^{-8}	5.109×10^{-7}	1.00106×10^{-3}



B3.

0.4 pt

$$C_1 = 5.196 \times 10^{-4}$$

Experiment



A1-5

中文 (Official)

Part C. Double layer cantilever beam

C1. 1.0 pt

T (K)	d (m)	$\bar{d} = d_0$ (m)
300	-2.28×10^{-5}	-2.836×10^{-5}
	-7.24×10^{-5}	
	-1.61×10^{-5}	
	-2.84×10^{-5}	
	-2.1×10^{-6}	
T (K)	$d - d_0 = \Delta d$ (m)	$\bar{\Delta d}$ (m)
301	2.8506×10^{-4}	2.7928×10^{-4}
	2.7186×10^{-4}	
	2.7466×10^{-4}	
	2.7436×10^{-4}	
	2.9046×10^{-4}	
301.5	4.1276×10^{-4}	4.2568×10^{-4}
	4.1336×10^{-4}	
	4.6276×10^{-4}	
	4.3956×10^{-4}	
	3.9996×10^{-4}	
302	5.4146×10^{-4}	5.4186×10^{-4}
	5.4676×10^{-4}	
	5.3386×10^{-4}	
	5.6706×10^{-4}	
	5.2016×10^{-4}	
302.5	6.9866×10^{-4}	6.7330×10^{-4}
	6.6726×10^{-4}	
	6.6416×10^{-4}	
	6.8296×10^{-4}	
	6.5346×10^{-4}	
303	7.6026×10^{-4}	7.9410×10^{-4}

Experiment



A1-6

中文 (Official)

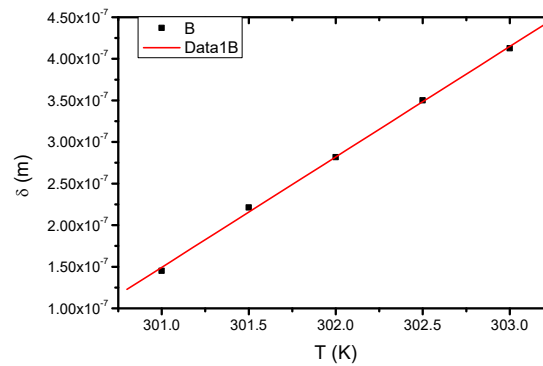
	7.7046×10^{-4}	
	7.9706×10^{-4}	
	8.1346×10^{-4}	
	8.2926×10^{-4}	

C2.

1.0 pt

T (K)	$\bar{\Delta d}$ (m)	δ (m)
301	2.7928×10^{-4}	1.451×10^{-7}
301.5	4.2568×10^{-4}	2.212×10^{-7}
302	5.4186×10^{-4}	2.816×10^{-7}
302.5	6.7330×10^{-4}	3.499×10^{-7}
303	7.9410×10^{-4}	4.127×10^{-7}

Slope: 1.337×10^{-7}



C3.

0.6 pt

$4.98 \times 10^{10} \text{ N/m}^2 \text{ (Pa)}$

Experiment



A1-7

中文 (Official)

Part D. Test of molecular-absorption-induced bending of a cantilever beam

D1. 0.6 pt

Sample 0	d (m)	$\bar{d} = d_0$ (m)
	3.4×10^{-6}	-7.2×10^{-6}
	-1.15×10^{-5}	
	-1.61×10^{-5}	
	2.09×10^{-5}	
	-3.25×10^{-5}	
Sample 1	$d - d_0 = \Delta d$ (m)	
	-8.2414×10^{-4}	-8.2552×10^{-4}
	-8.2884×10^{-4}	
	-8.2794×10^{-4}	
	-8.1934×10^{-4}	
	-8.2584×10^{-4}	

D2. Assume the function form of the displacement and coverage ratio (CR) 0.6 pt

can be expressed as : $\delta = C_2 \frac{\text{CoverageRatio}}{EI^*} L^4$. Estimate C_2 based on your data obtained in A9. You can use the correlation between δ and $\bar{\Delta d}$ in A6.

$$\underline{-7.89 \times 10^{-2}}$$

Experiment



A1-8

中文 (Official)

D3.

0.8 pt

Sample 2	$d - d_0 = \Delta d$ (m)	$\overline{\Delta d}$ (m)
	-6.1734×10^{-4}	-6.0866×10^{-4}
	-6.0434×10^{-4}	
	-6.0054×10^{-4}	
	-5.9884×10^{-4}	
-6.2224×10^{-4}		
Sample 3	$d - d_0 = \Delta d$ (m)	$\overline{\Delta d}$ (m)
	-2.4924×10^{-4}	-2.4588×10^{-4}
	-2.6224×10^{-4}	
	-2.4764×10^{-4}	
	-2.4854×10^{-4}	
-2.2174×10^{-4}		

D4.

0.6 pt

Sample 2: 0.738%

Sample 3: 0.298%