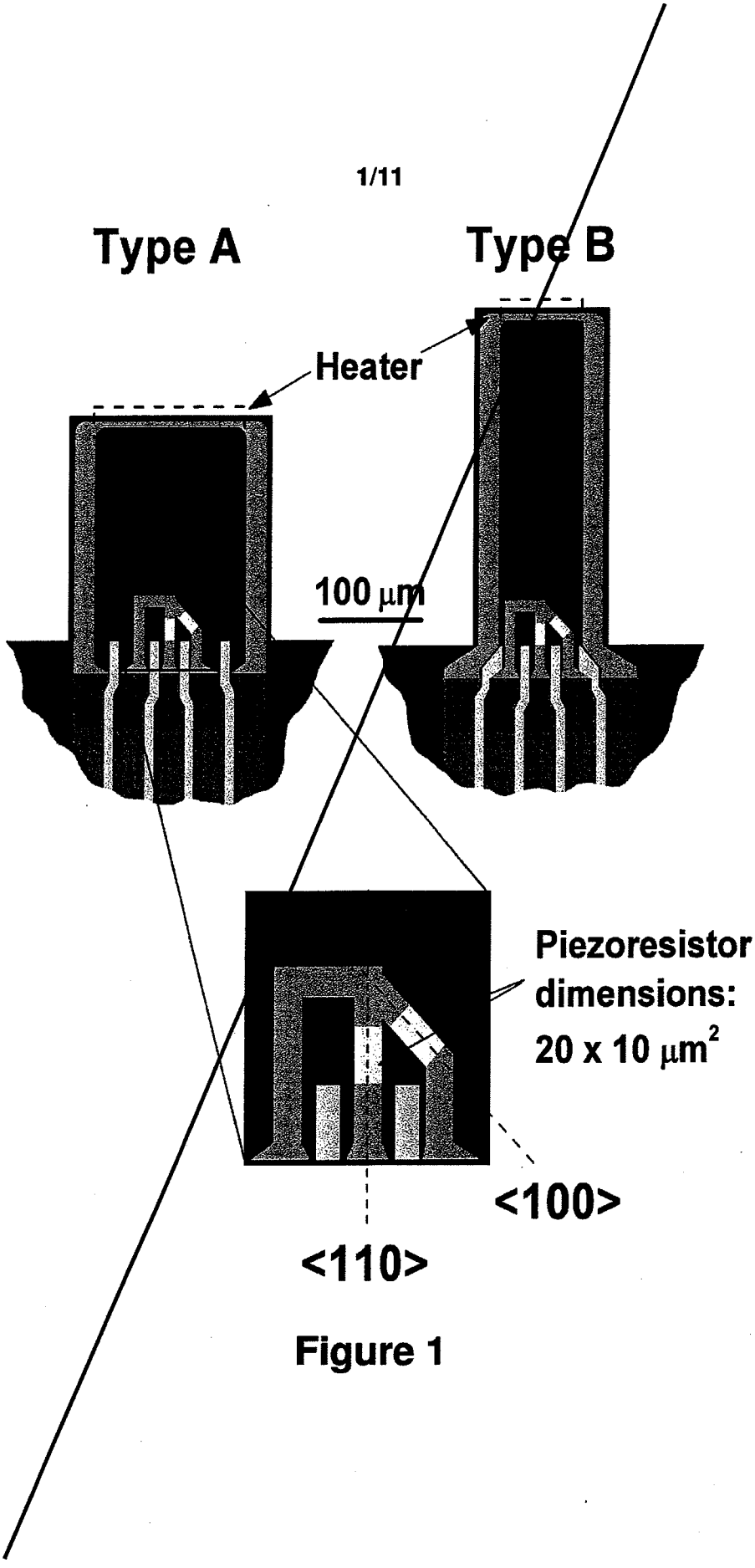

Type A
Type B
Heater
100 μm
Piezoresistor
dimensions:
20 x 10 μm²
<100>
<110>

Figure 1

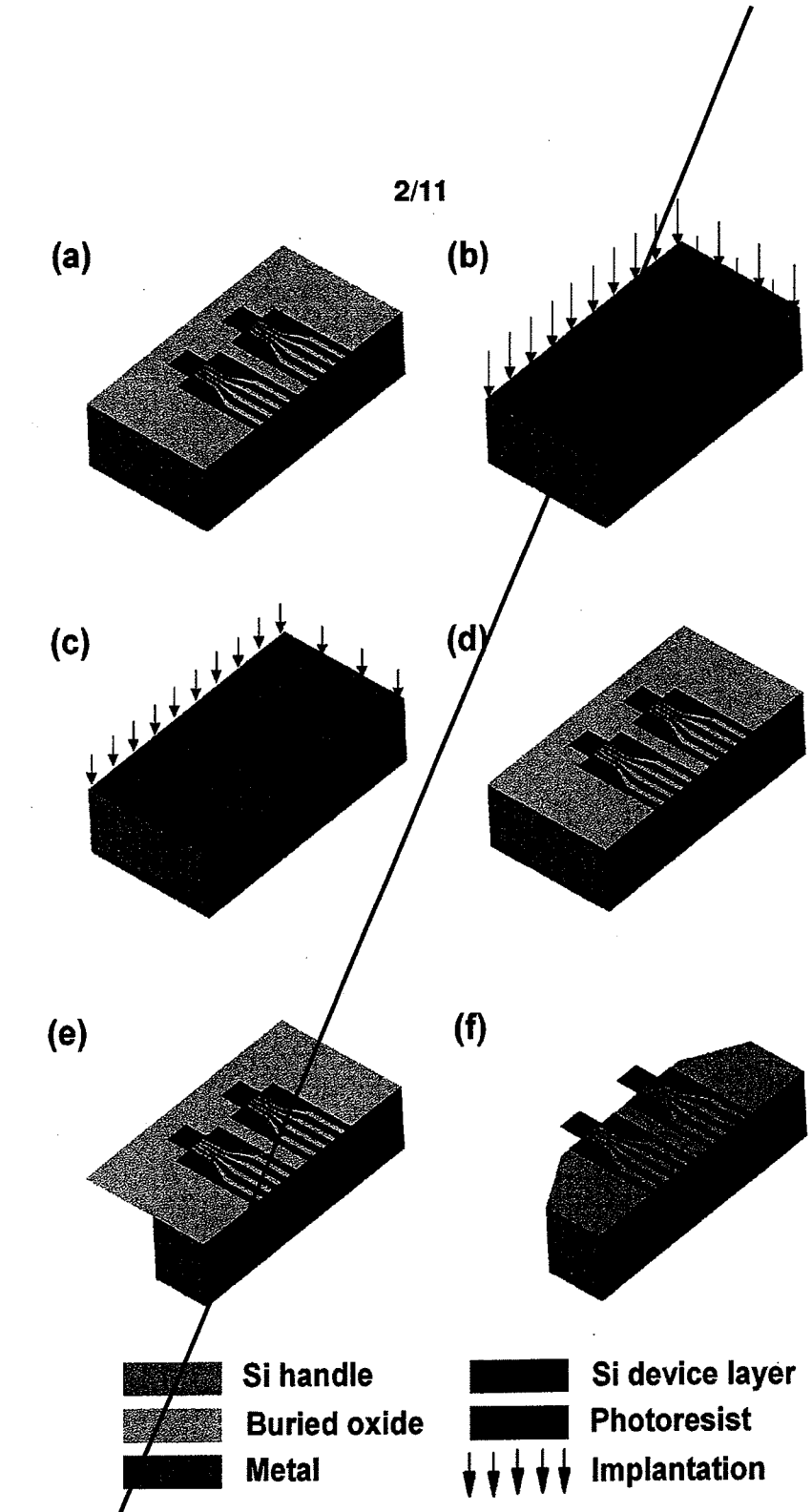

(a)
(b)
(c)
(d)
(e)
(f)
Si handle
Buried oxide
Metal
Si device layer
Photoresist
Implantation

Figure 2

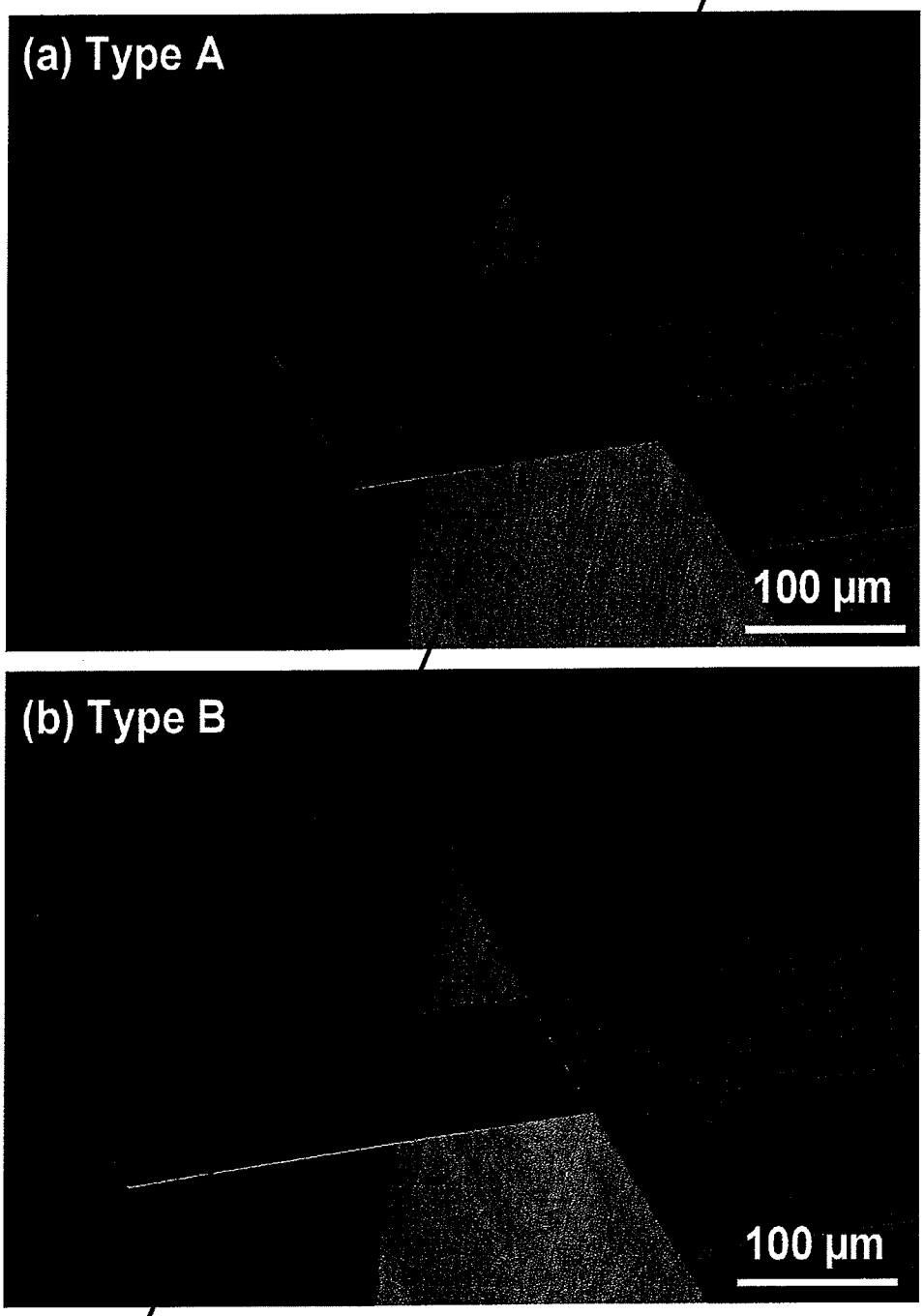


Figure 3

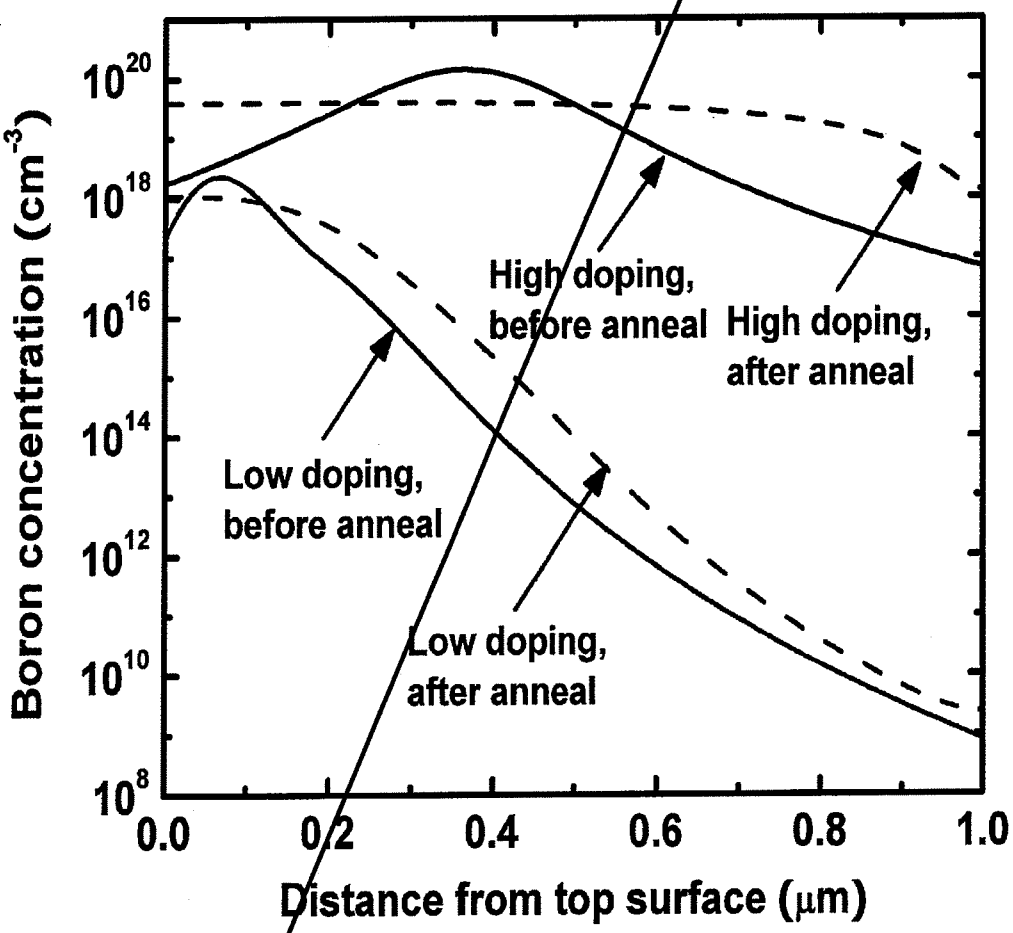

Boron concentration (cm^{-3})
10^{20}
10^{18}
10^{16}
10^{14}
10^{12}
10^{10}
10^{8}
0.0
0.2
0.4
0.6
0.8
1.0
Distance from top surface (μm)
High doping, before anneal
High doping, after anneal
Low doping, before anneal
Low doping, after anneal

Figure 4

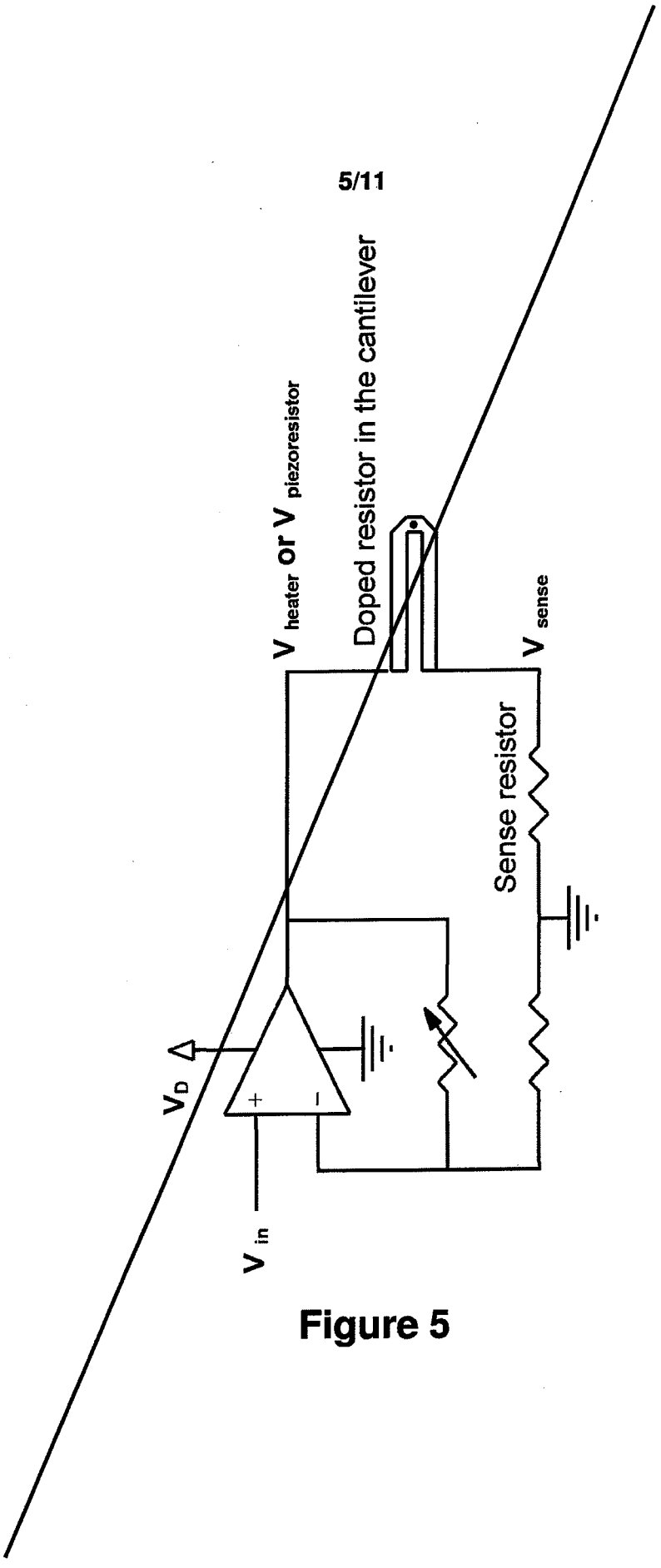

V heater or V piezoresistor
Doped resistor in the cantilever
V sense
Sense resistor
V D
+
-
V in

Figure 5

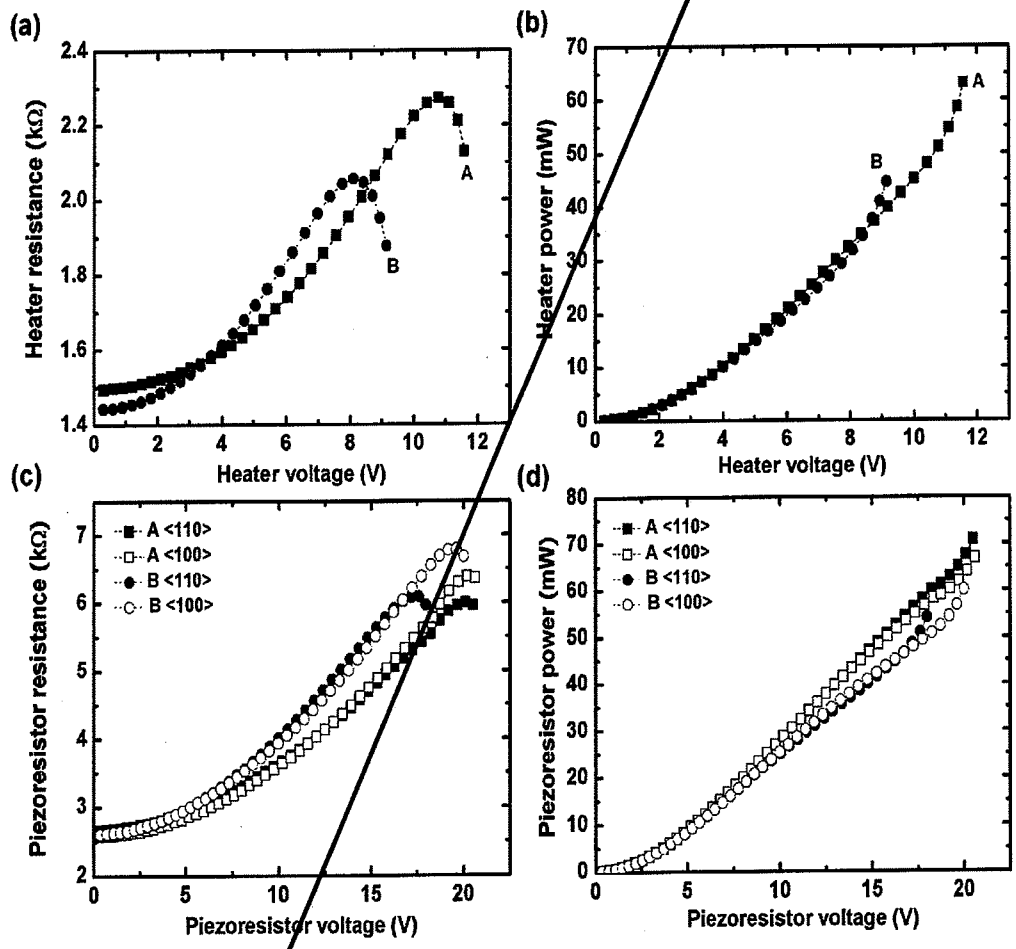

(a)
Heater resistance (kΩ)
Heater voltage (V)
A
B
(b)
Heater power (mW)
Heater voltage (V)
A
B
(c)
Piezoresistor resistance (kΩ)
Piezoresistor voltage (V)
A <110>
A <100>
B <110>
B <100>
(d)
Piezoresistor power (mW)
Piezoresistor voltage (V)
A <110>
A <100>
B <110>
B <100>

Figure 6

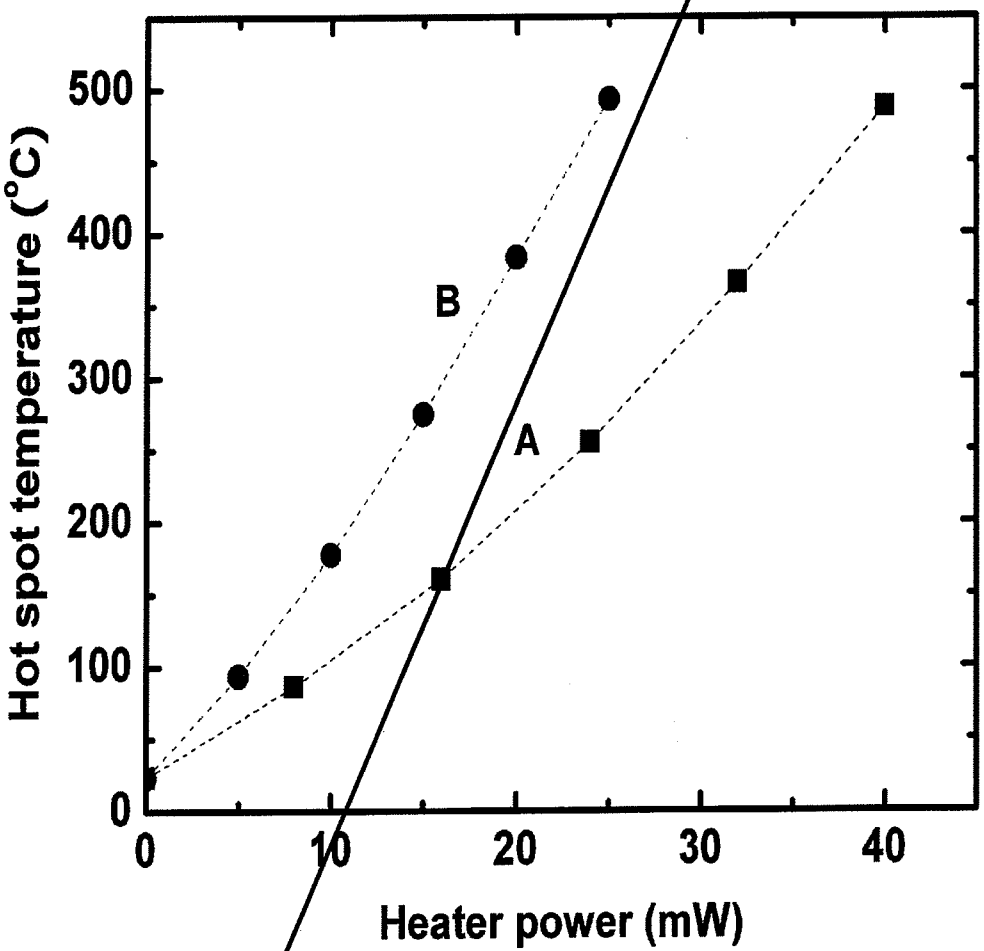

Hot spot temperature (°C)
500
400
300
200
100
0
0
10
20
30
40
Heater power (mW)
B
A

Figure 7

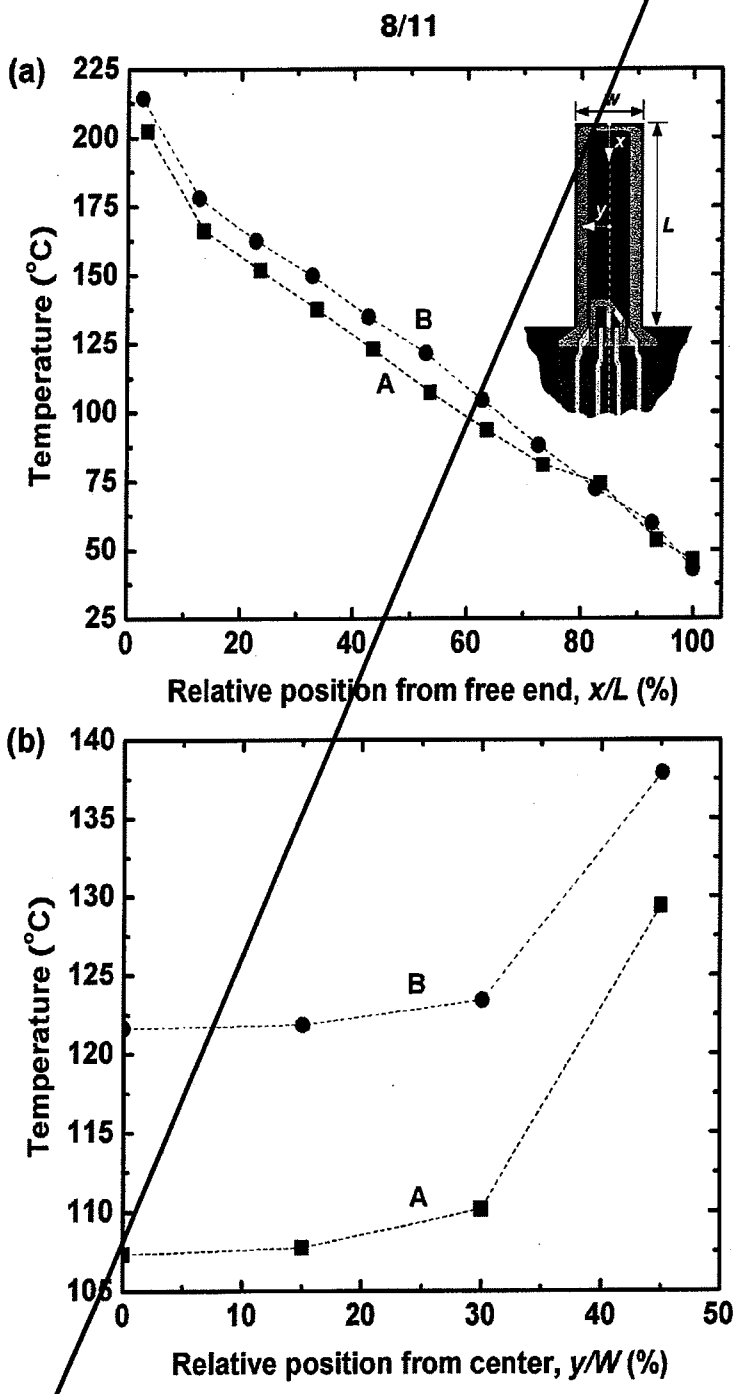

(a)
Temperature (°C)
225
200
175
150
125
100
75
50
25
0
20
40
60
80
100
Relative position from free end, x/L (%)
B
A
W
x
y
L
(b)
Temperature (°C)
140
135
130
125
120
115
110
105
0
10
20
30
40
50
Relative position from center, y/W (%)
B
A

Figure 8

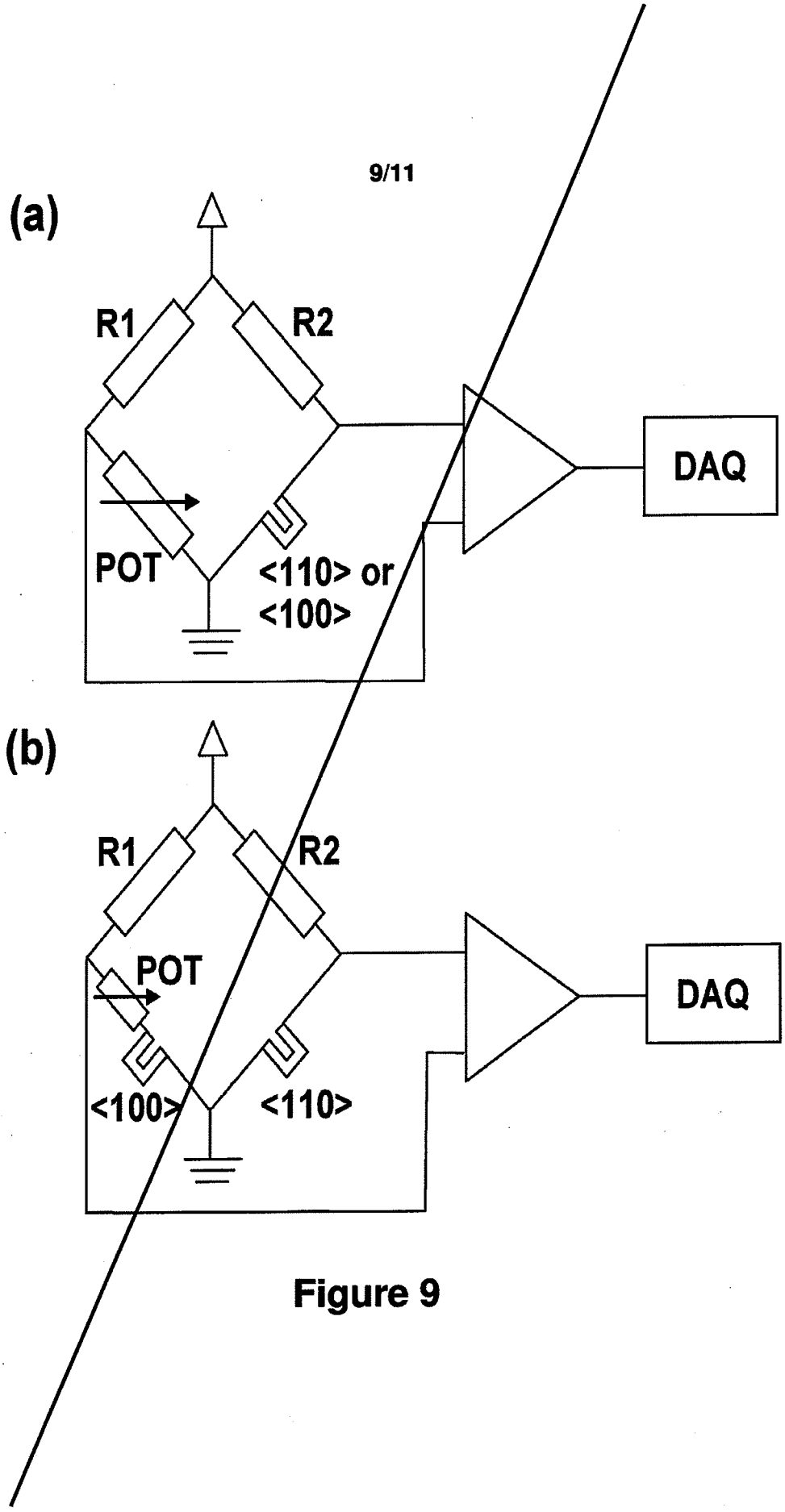


Figure 9

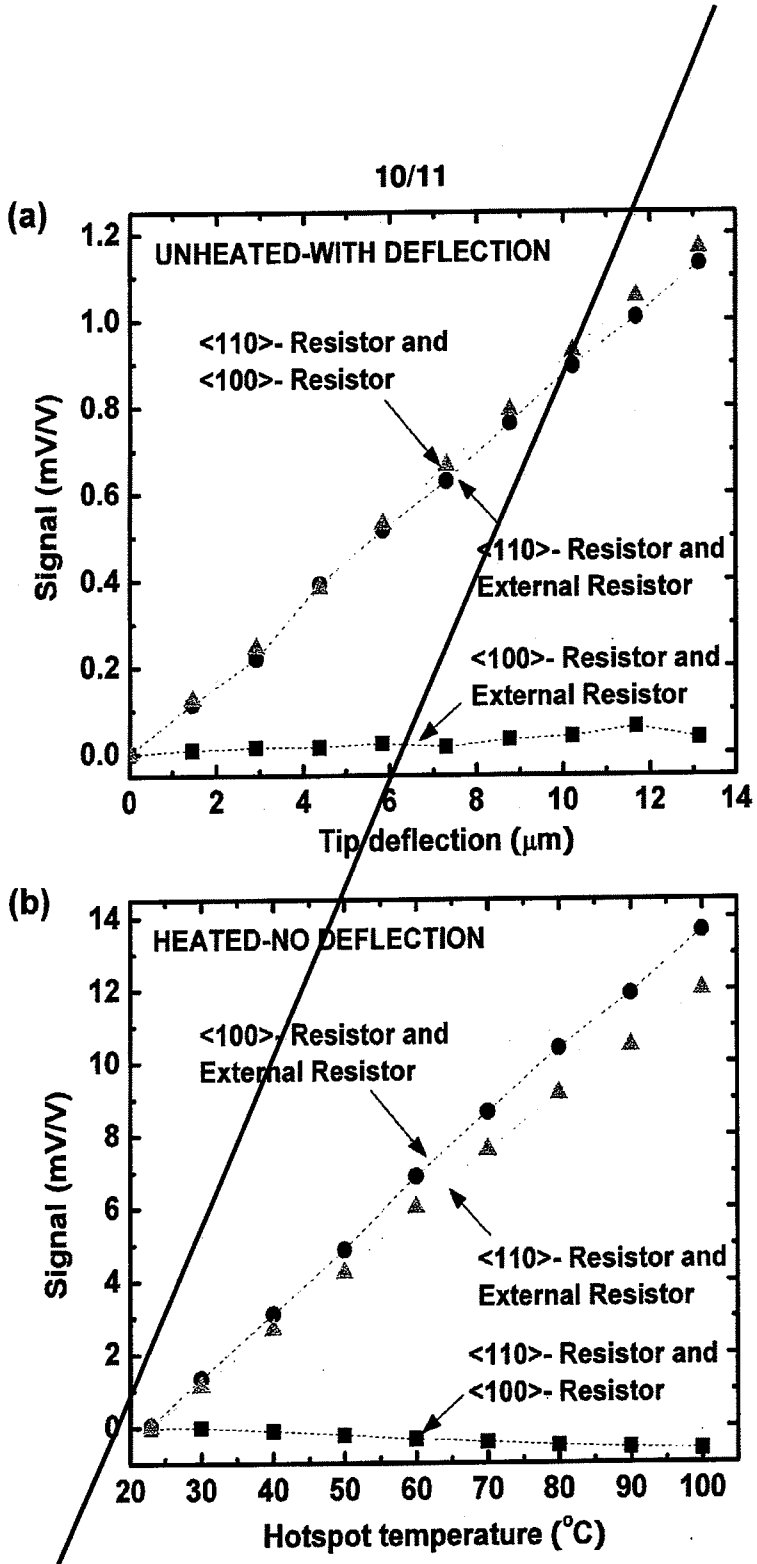

(a)
UNHEATED-WITH DEFLECTION
<110>- Resistor and
<100>- Resistor
<110>- Resistor and
External Resistor
<100>- Resistor and
External Resistor
Signal (mV/V)
Tip deflection (μm)
(b)
HEATED-NO DEFLECTION
<100>- Resistor and
External Resistor
<110>- Resistor and
External Resistor
<110>- Resistor and
<100>- Resistor
Signal (mV/V)
Hotspot temperature (°C)

Figure 10

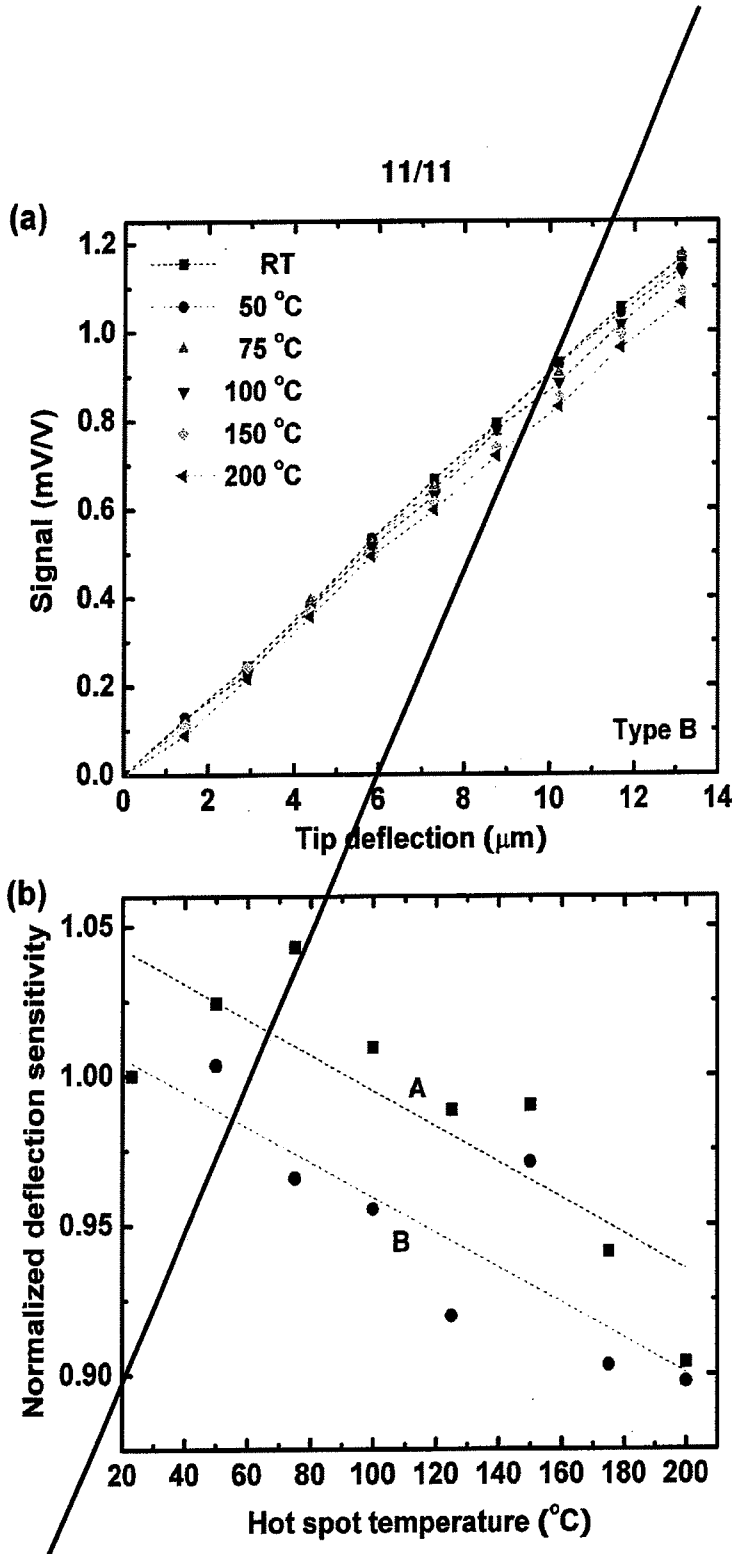

(a)
RT
50 °C
75 °C
100 °C
150 °C
200 °C
Signal (mV/V)
Tip deflection (μm)
Type B
(b)
Normalized deflection sensitivity
Hot spot temperature (°C)
A
B

Figure 11

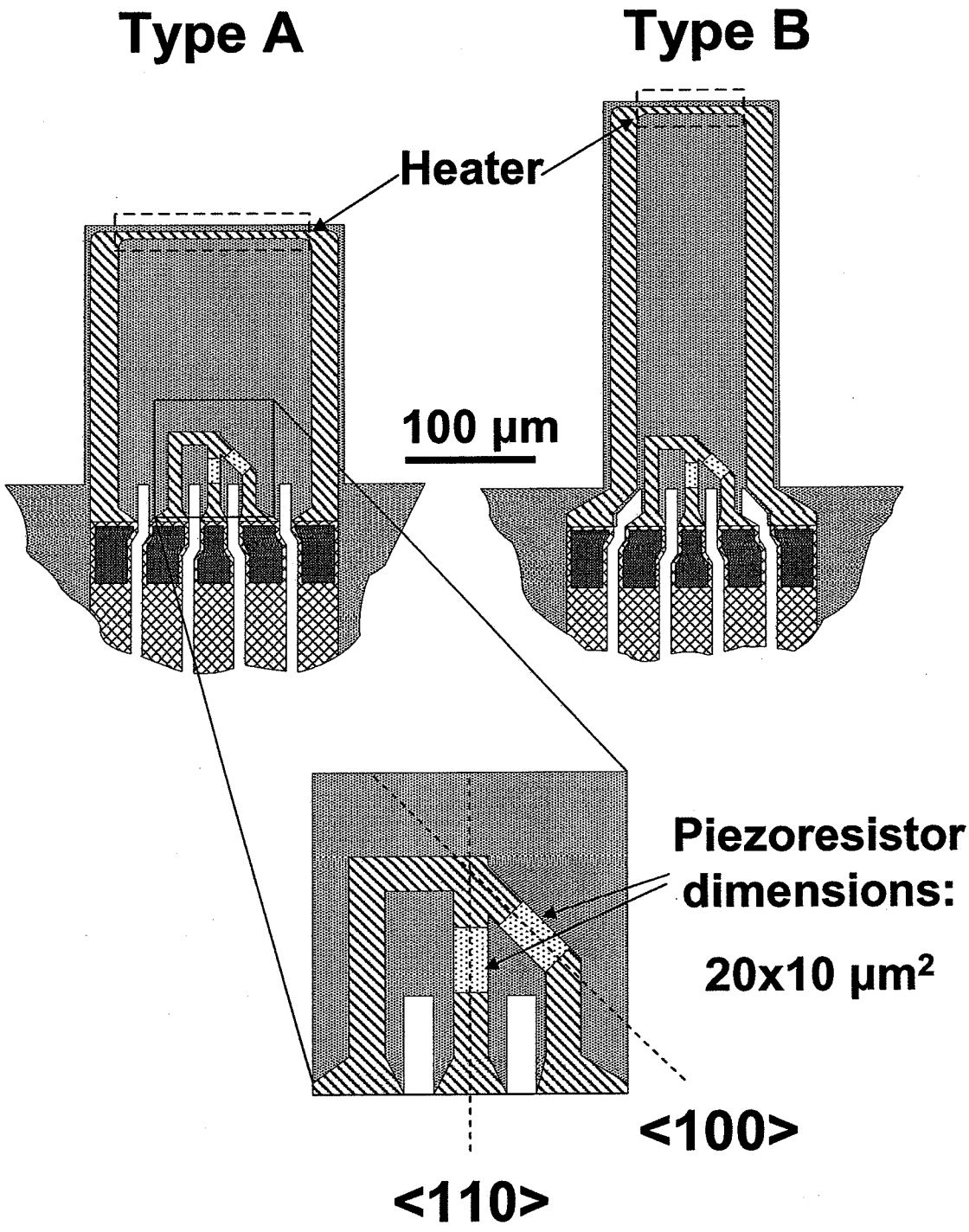

Type A
Type B
Heater
100 µm
Piezoresistor dimensions:
20x10 µm²
<100>
<110>

Figure 1

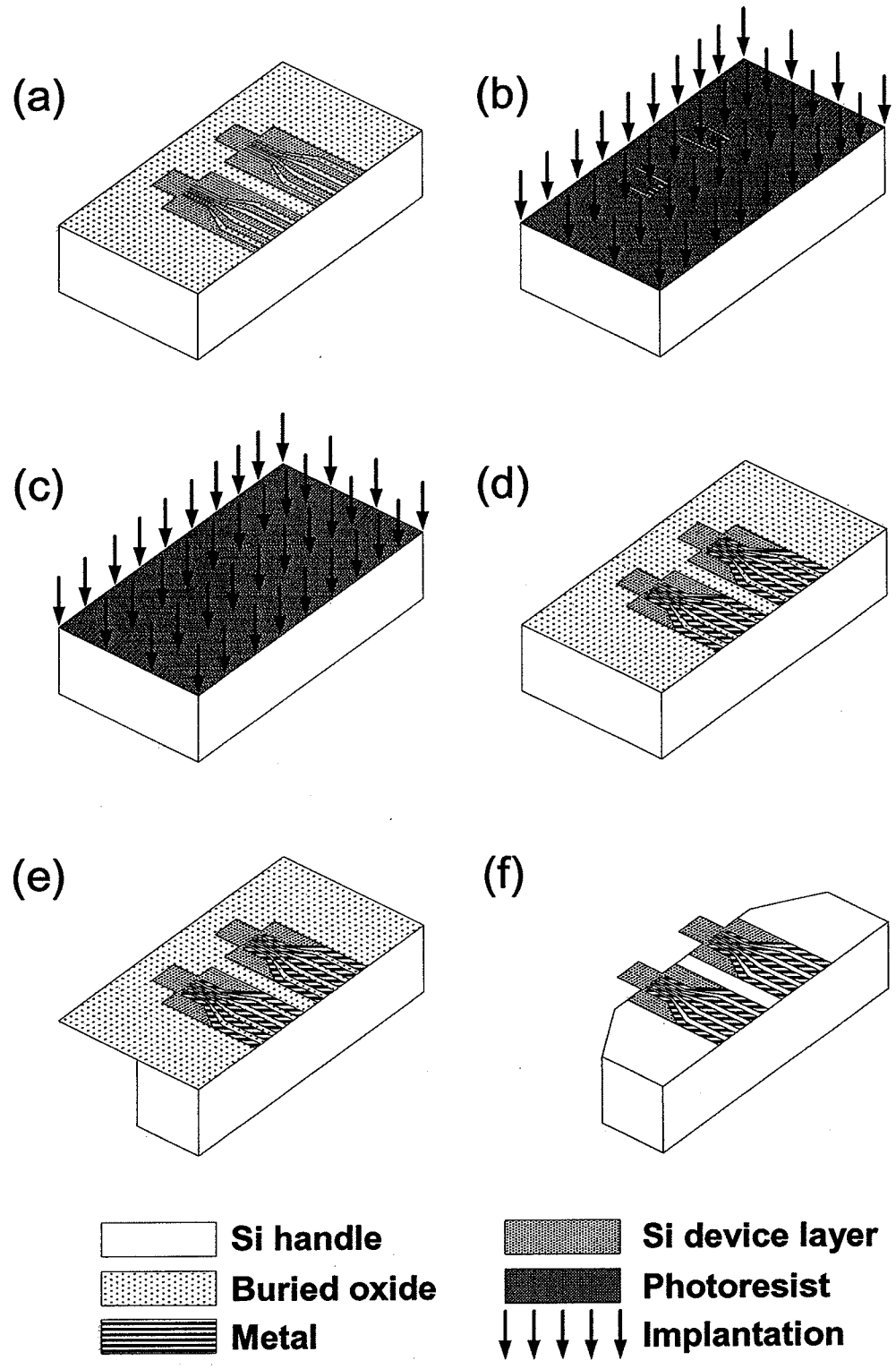

(a)
(b)
(c)
(d)
(e)
(f)
Si handle
Buried oxide
Metal
Si device layer
Photoresist
Implantation

Figure 2

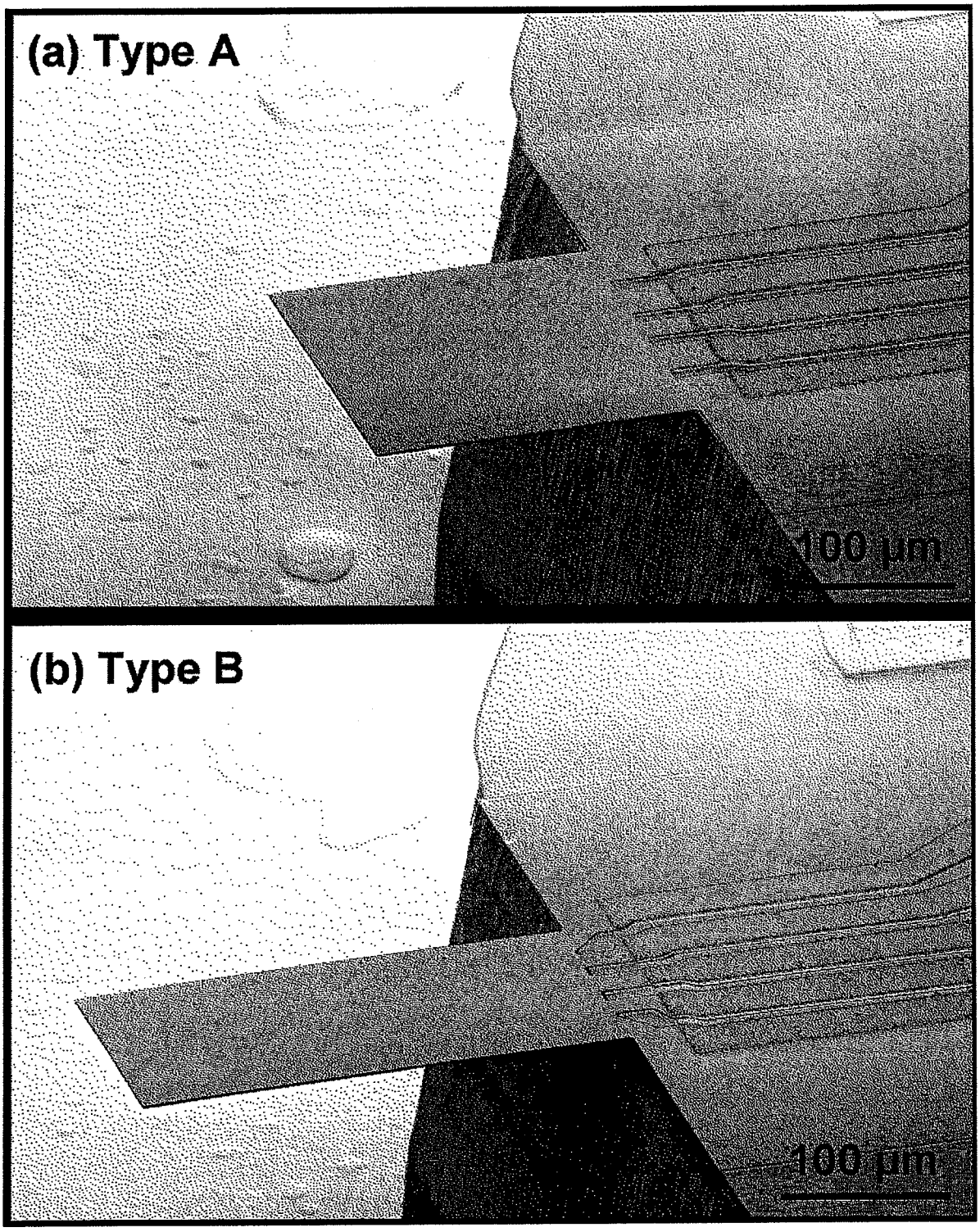


Figure 3

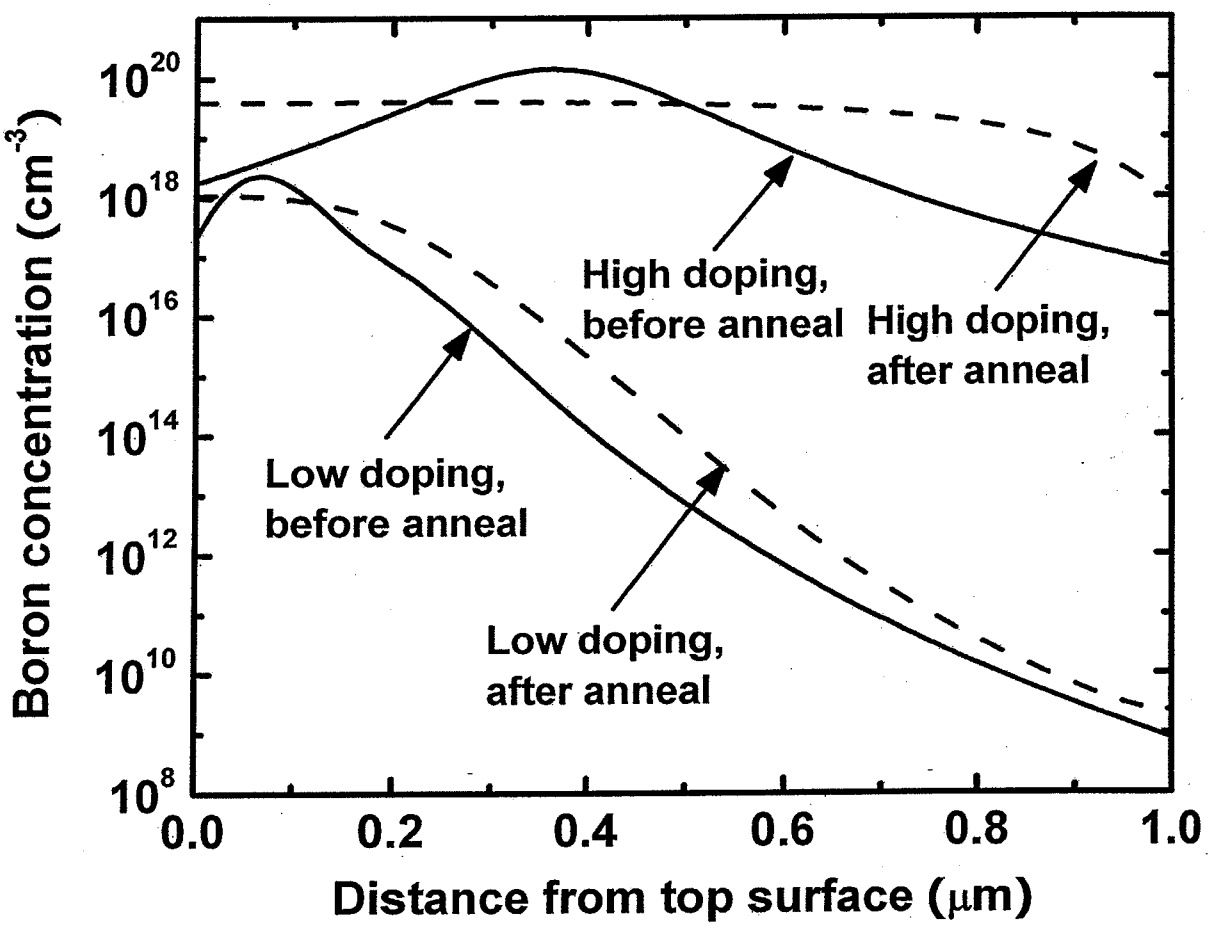

Boron concentration (cm^{-3})
10^{20}
10^{18}
10^{16}
10^{14}
10^{12}
10^{10}
10^{8}
0.0
0.2
0.4
0.6
0.8
1.0
Distance from top surface (μm)
High doping, before anneal
High doping, after anneal
Low doping, before anneal
Low doping, after anneal

Figure 4

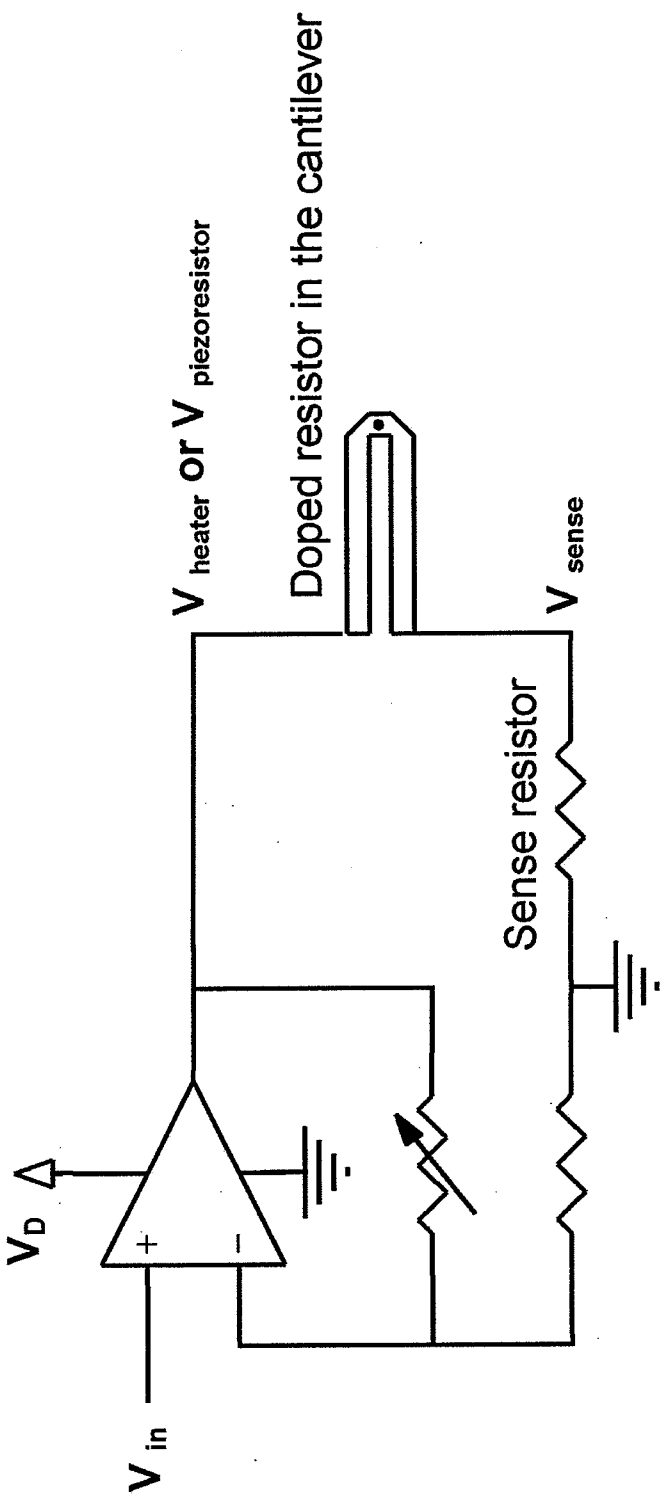

V heater or V piezoresistor
Doped resistor in the cantilever
V sense
Sense resistor
V D
+
−
V in

Figure 5

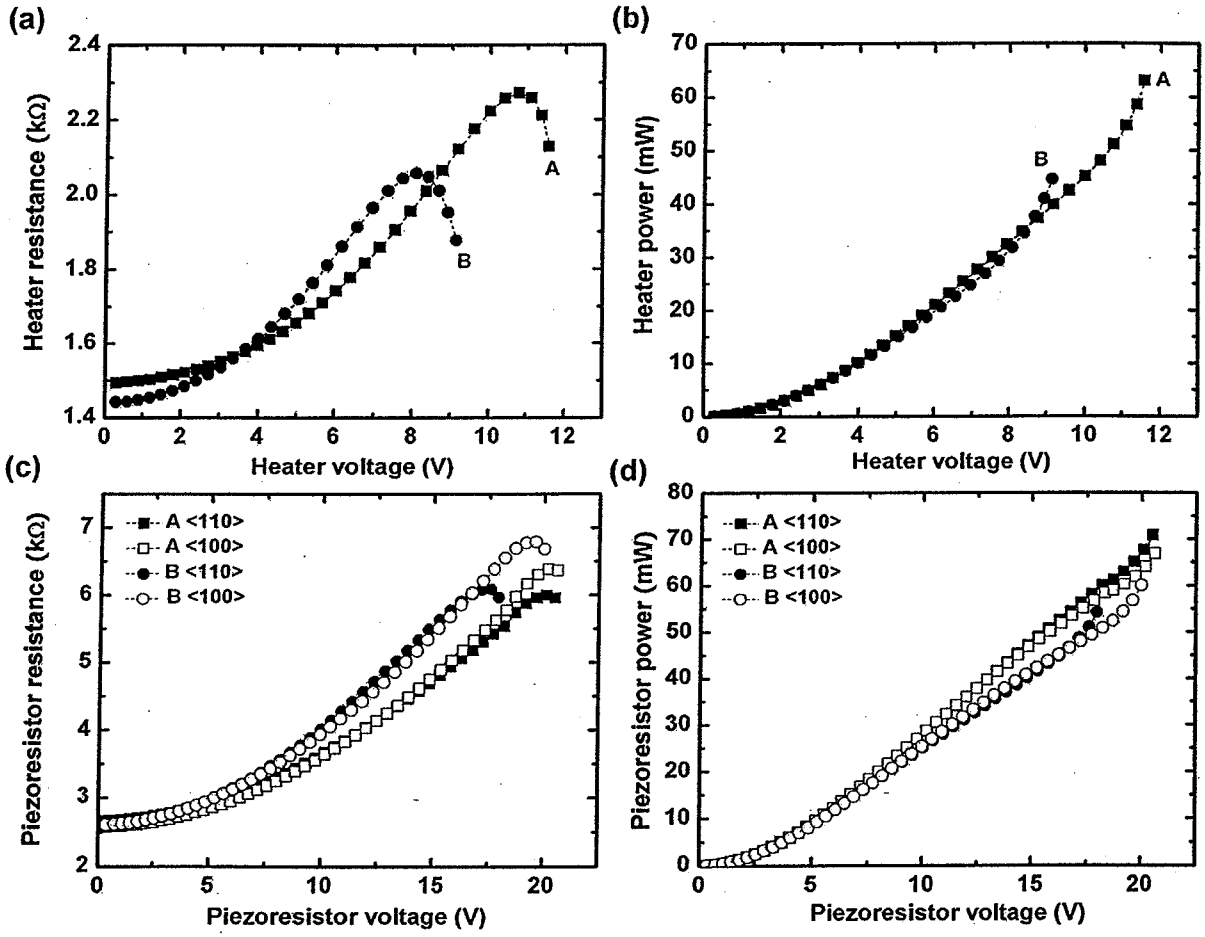

(a)
Heater resistance (kΩ)
Heater voltage (V)
A
B
(b)
Heater power (mW)
Heater voltage (V)
A
B
(c)
Piezoresistor resistance (kΩ)
Piezoresistor voltage (V)
A <110>
A <100>
B <110>
B <100>
(d)
Piezoresistor power (mW)
Piezoresistor voltage (V)
A <110>
A <100>
B <110>
B <100>

Figure 6

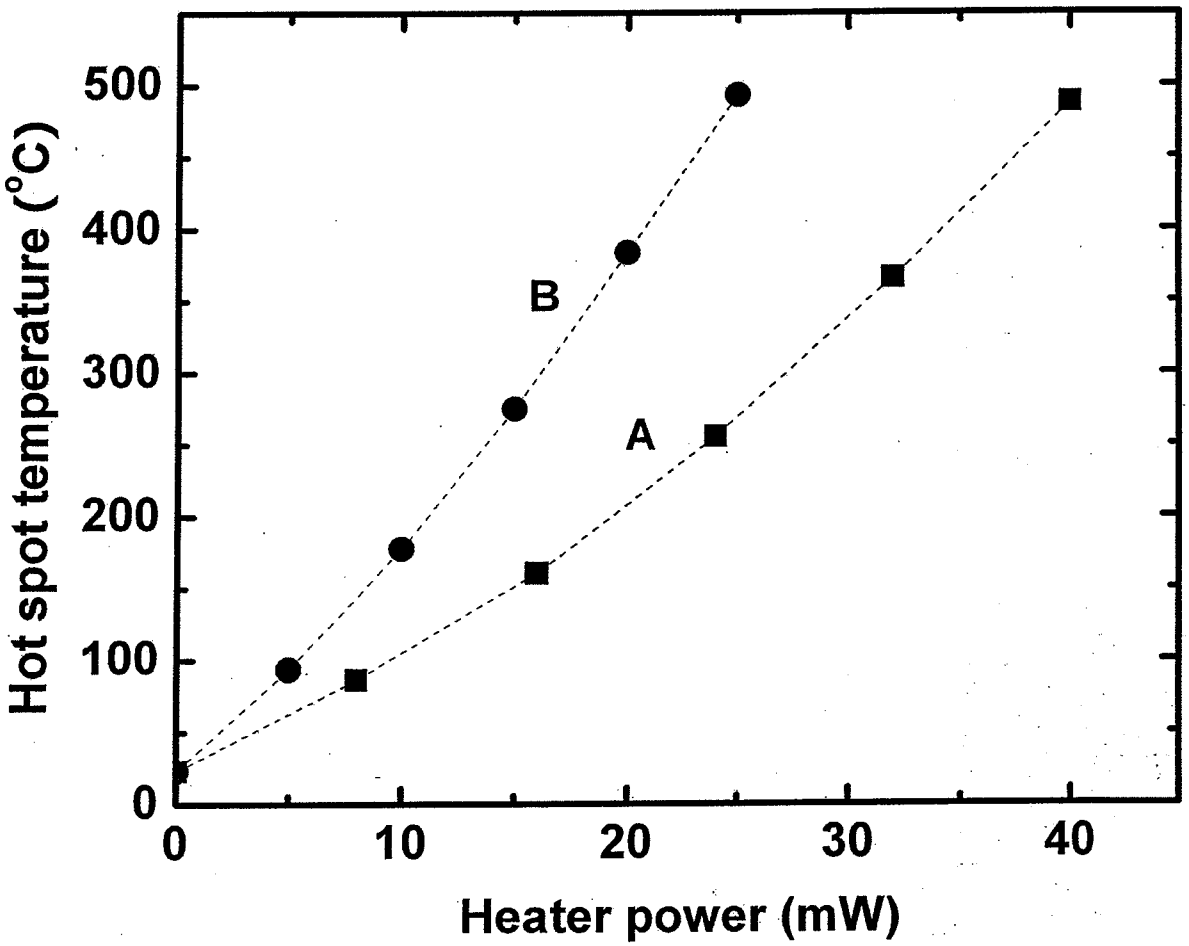

Hot spot temperature (°C)
500
400
300
200
100
0
0
10
20
30
40
Heater power (mW)
B
A

Figure 7

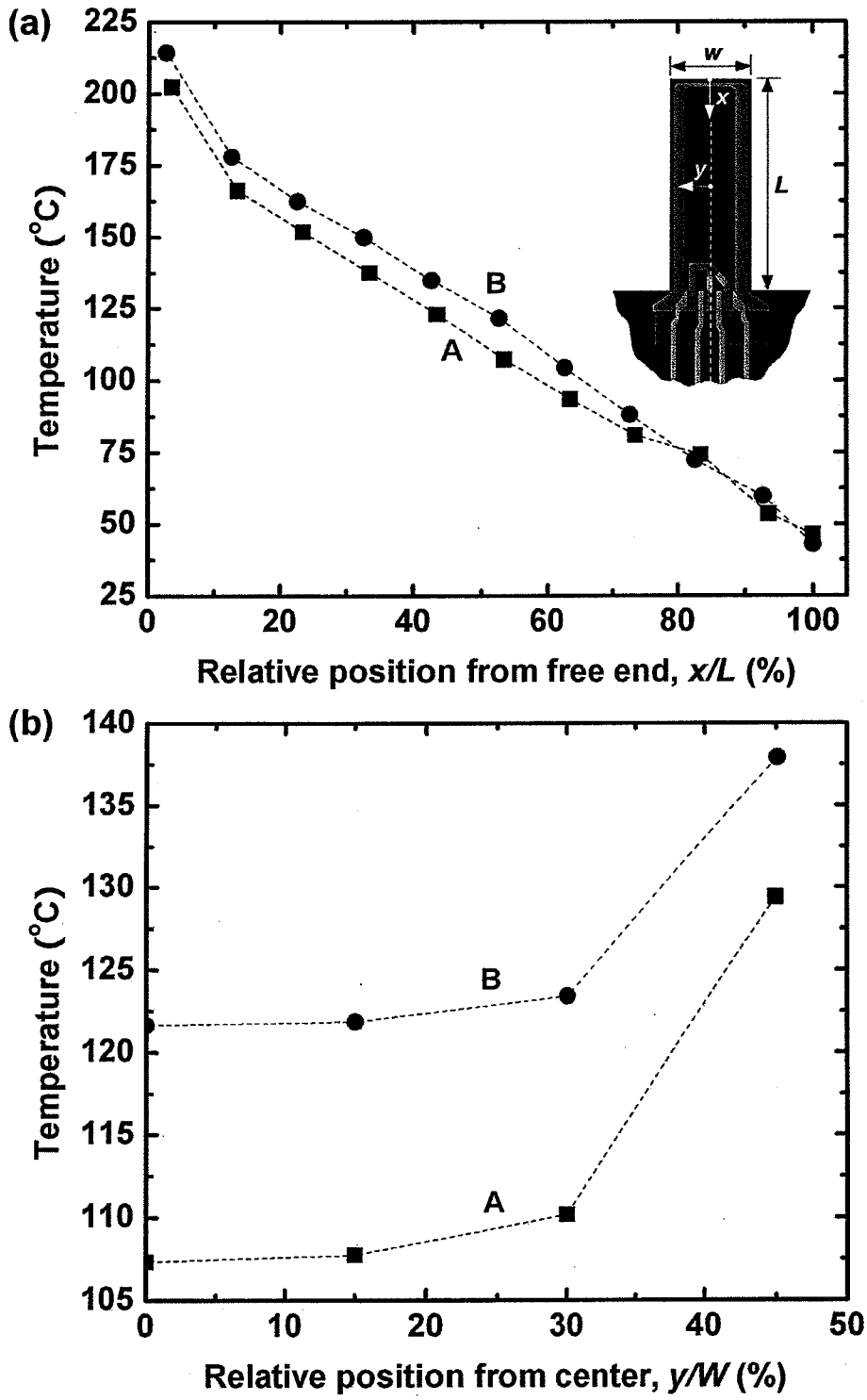

(a)
Temperature (°C)
225
200
175
150
125
100
75
50
25
0
20
40
60
80
100
Relative position from free end, x/L (%)
B
A
w
x
y
L
(b)
Temperature (°C)
140
135
130
125
120
115
110
105
0
10
20
30
40
50
Relative position from center, y/W (%)
B
A

Figure 8

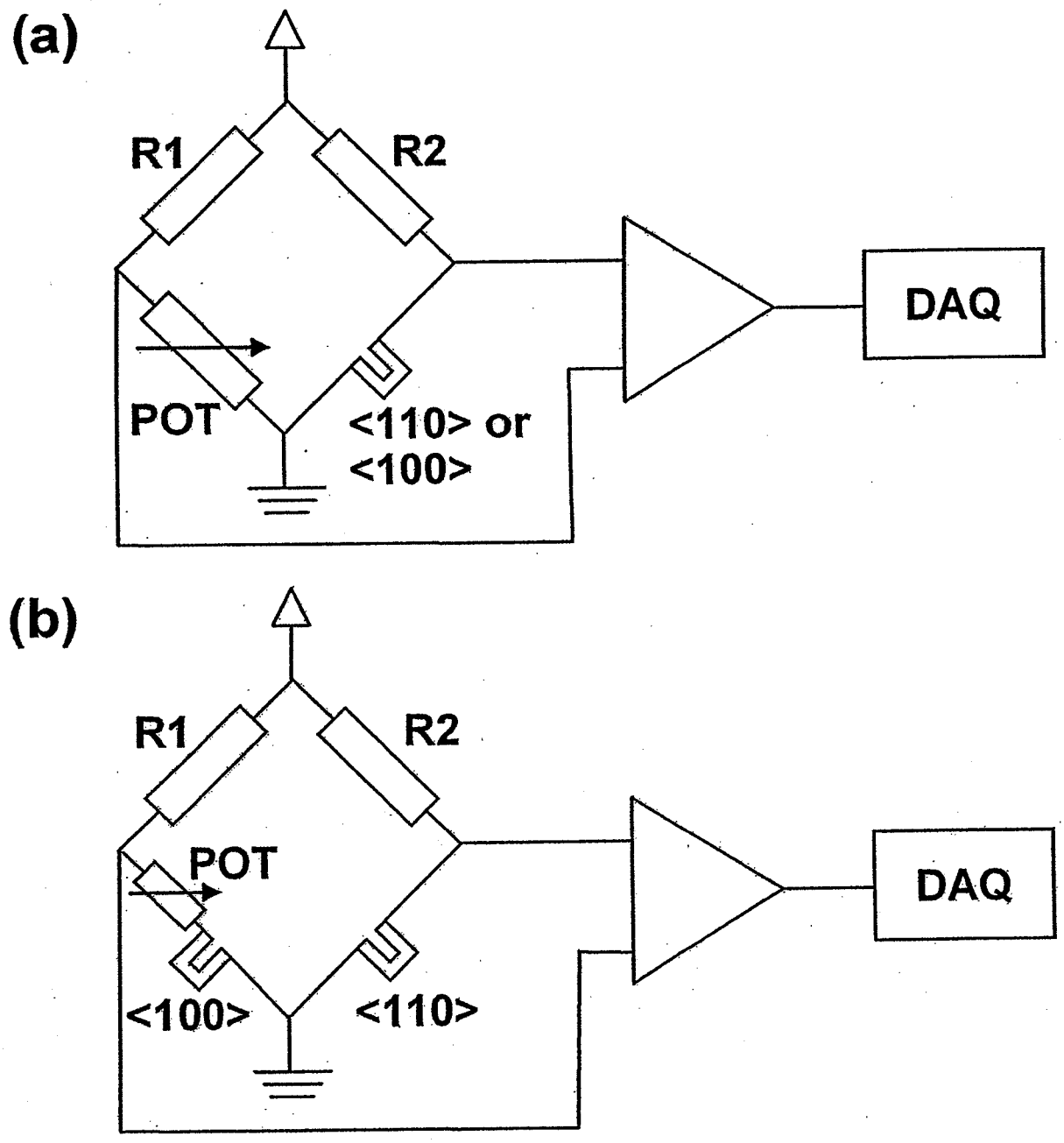


Figure 9

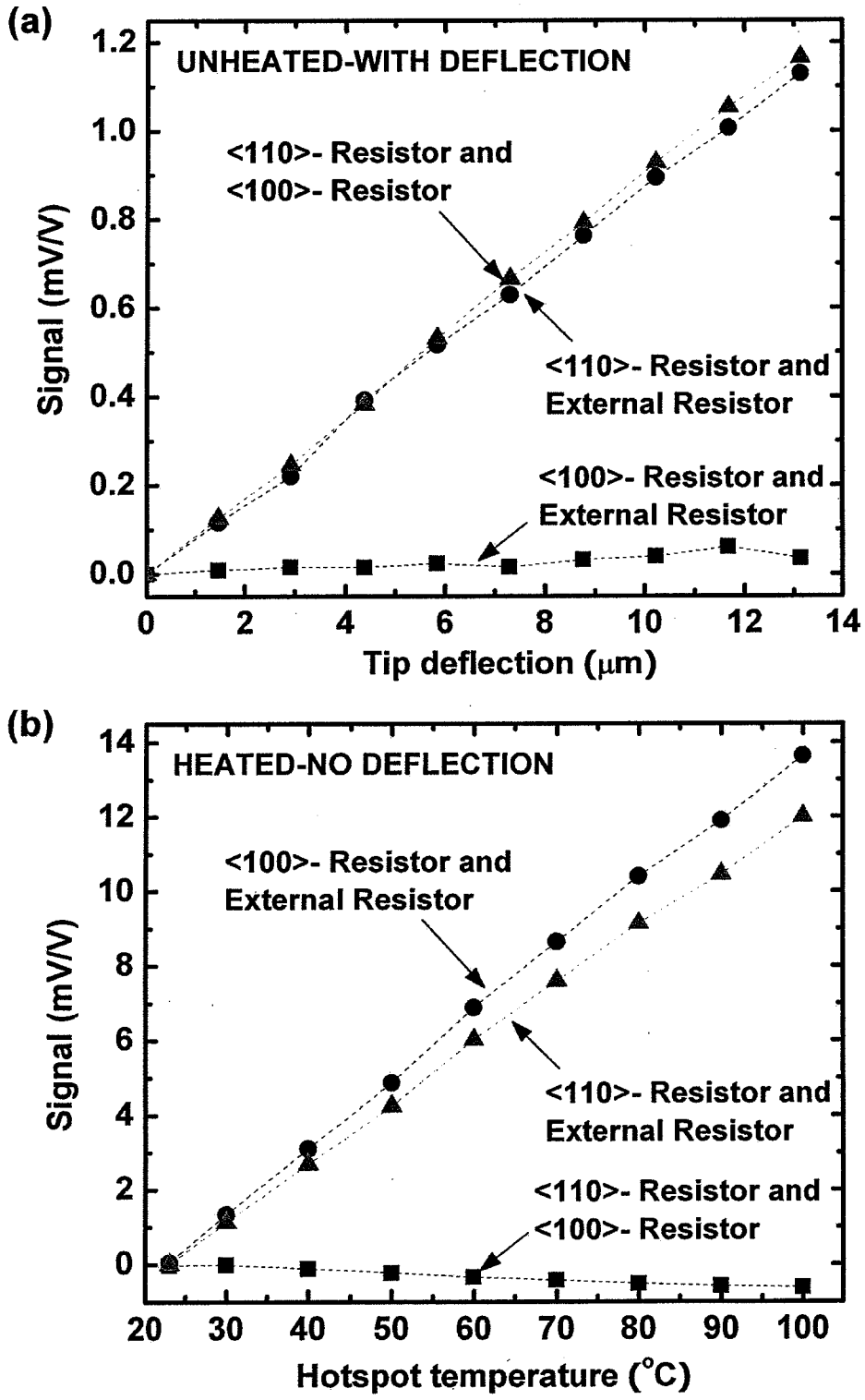

(a)
UNHEATED-WITH DEFLECTION
<110>- Resistor and
<100>- Resistor
<110>- Resistor and
External Resistor
<100>- Resistor and
External Resistor
Signal (mV/V)
Tip deflection (μm)
(b)
HEATED-NO DEFLECTION
<100>- Resistor and
External Resistor
<110>- Resistor and
External Resistor
<110>- Resistor and
<100>- Resistor
Signal (mV/V)
Hotspot temperature (°C)

Figure 10

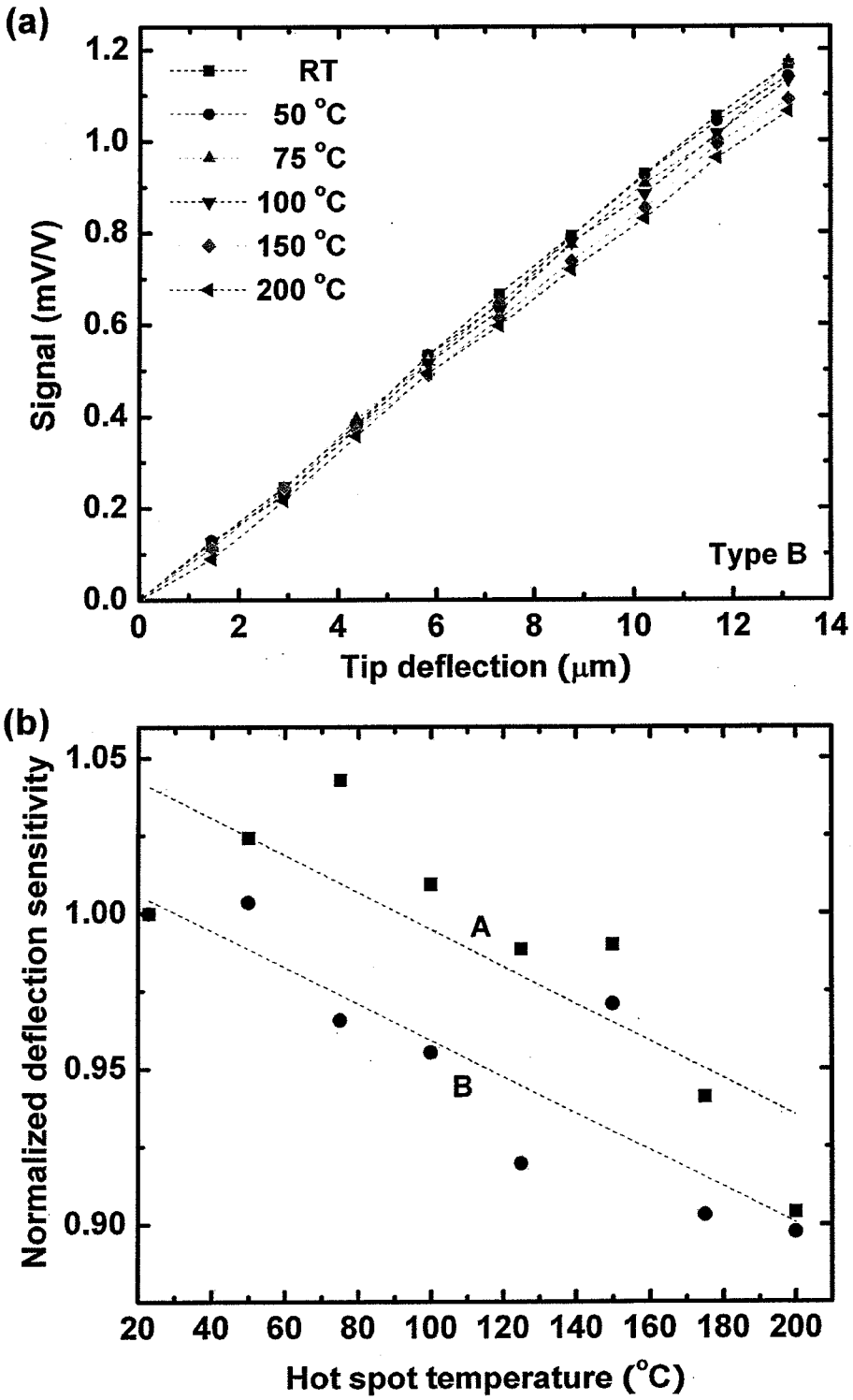

(a)
Signal (mV/V)
Tip deflection (μm)
RT
50 °C
75 °C
100 °C
150 °C
200 °C
Type B
(b)
Normalized deflection sensitivity
Hot spot temperature (°C)
A
B

Figure 11