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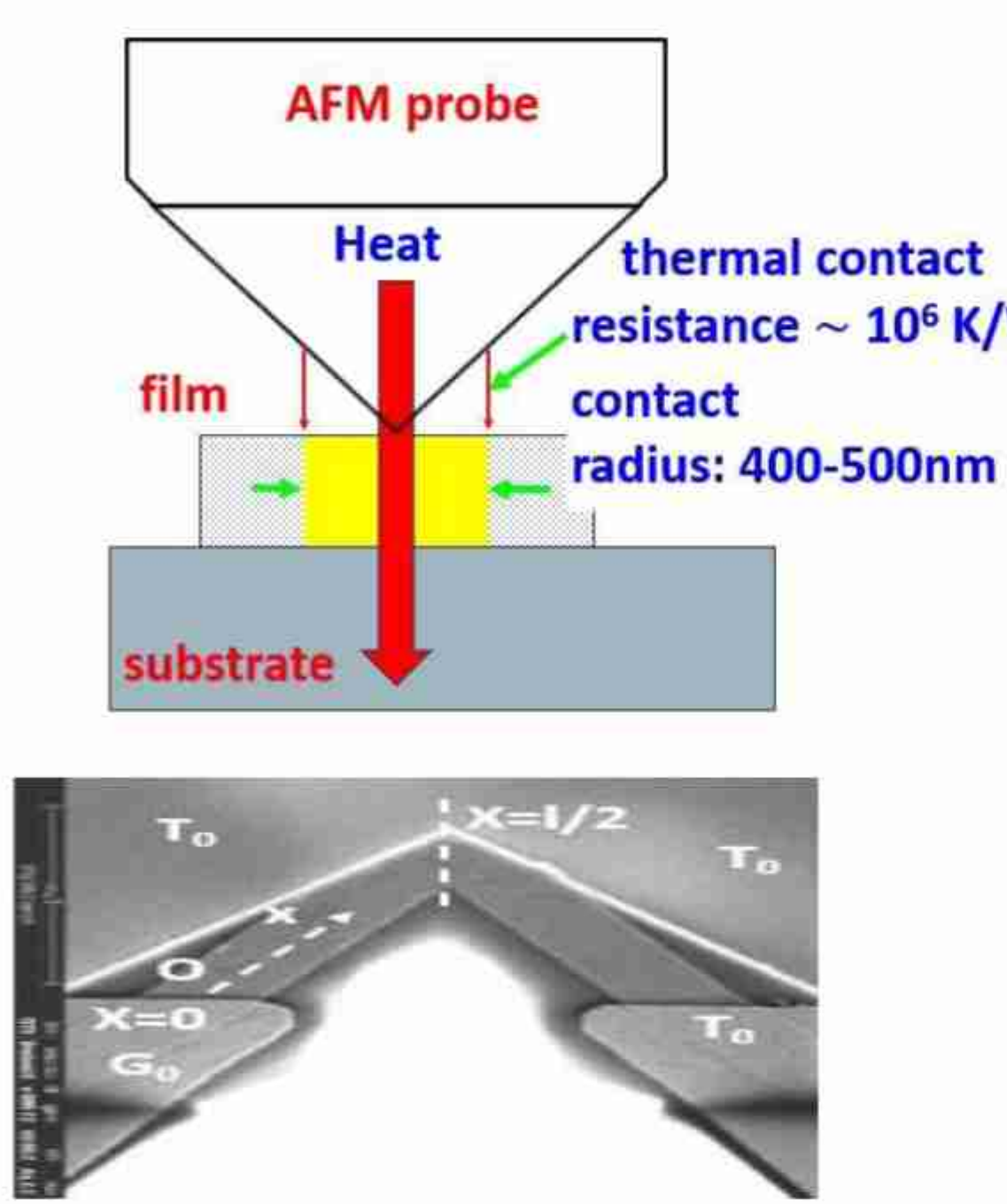
DC SCANNING THERMAL MICROSCOPY FOR THERMAL CONDUCTIVITY MEASUREMENT OF NANOMATERIALS WITH SUBMICRON SPATIAL RESOLUTION

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Laser-Surface-Plasma Interactions Laboratory

PROBE-SPECIMEN INTERACTION



Theoretical model – Heat conduction equation - 1D

$$\frac{d^2 T^*}{dx^2} - \left(\frac{hp_2}{k_2 A_2} - \rho_0 \frac{TCR \cdot I^2}{k_2 A_1 A_2} \right) T^* + \rho_0 \frac{I^2}{k_2 A_1 A_2} = 0$$

$T^* = T - T_0$ is the probe temperature rise in respect to T_0

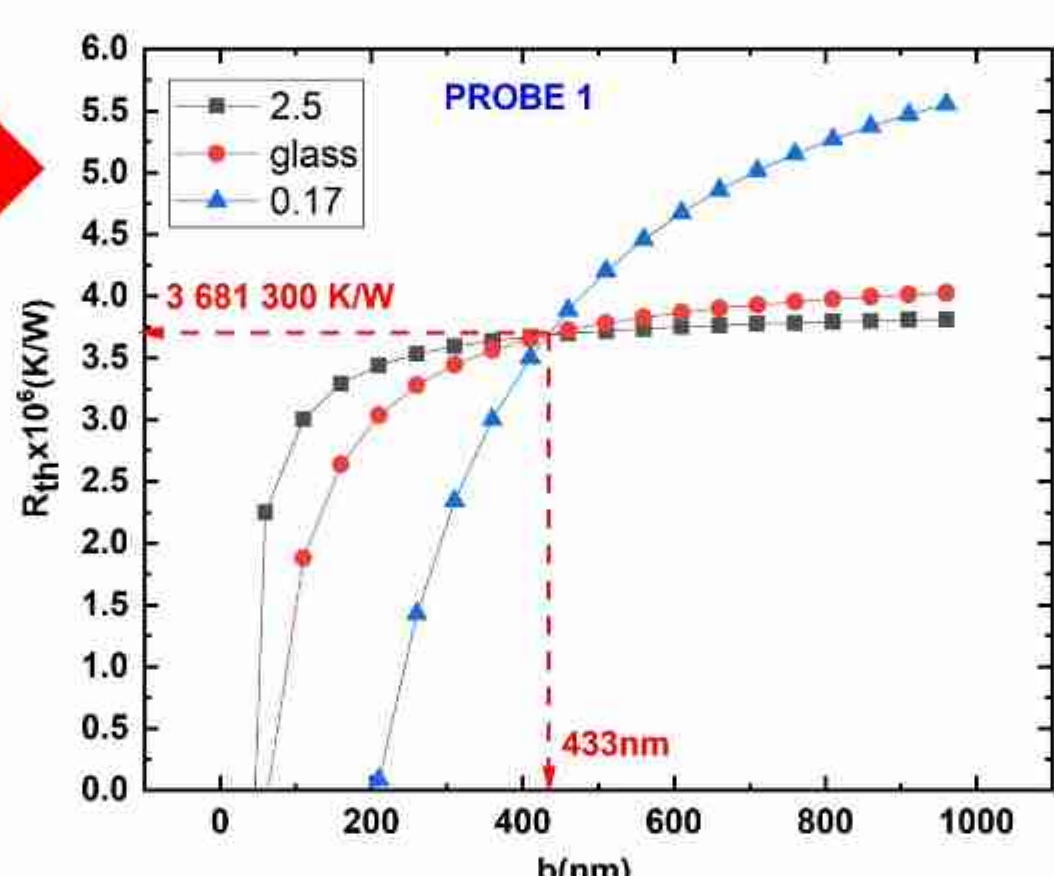
Boundary conditions

- i) For $x=0$ (at Pd strip base), $k_2 A_2 \frac{\partial T^*}{\partial x} \Big|_{x=0} = G_0 T^*(0)$
ii) For $x=l/2$ (in the middle of Pd strip), $-k_2 A_2 \frac{\partial T^*}{\partial x} \Big|_{x=l/2} = \frac{Q_s}{2}$

Intersection method for finding contact parameters:

b- contact radius
 R_{th} – thermal contact resistance

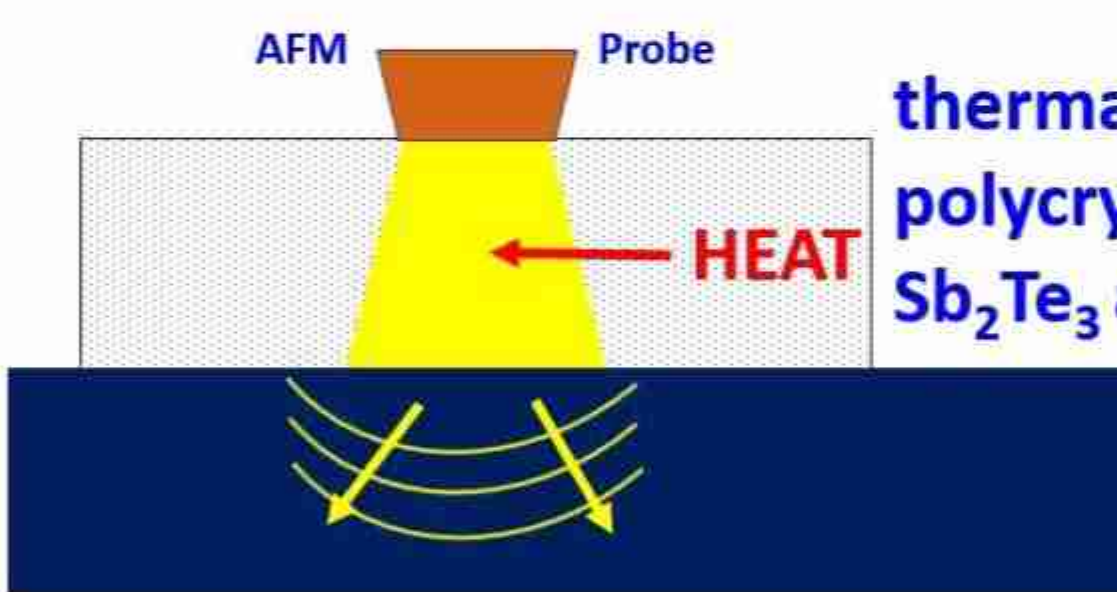
$R_{th, contact} = f(b, R_{th})$ & $R_{th, contact} = \text{known} \rightarrow R_{th} = f(b)$



contact radius
in the nm range
400-500nm
heating spot < 1μm

b=433nm | $R_{th} \sim 10^6$ K/W

THIN FILMS THERMAL CONDUCTIVITY VALIDATION
and MEASUREMENT (2D NANOMATERIALS)



thermal evaporation
polycrystalline film-85nm thick
 Sb_2Te_3 and $Bi_{0.35}Sb_{1.65}Te_3$
substrate- semi-infinite
glass

Sb_2Te_3 film measured value: **0.349 W/mK**
 $Bi_{0.35}Sb_{1.65}Te_3$ film measured value: **0.697 W/mK**

Reference value: **0.35 W/mK , 0.2% error**
Reference value: **0.655 W/mK , 6% error**

CONCLUSION:

High spatial resolution measurement method
realized for thin films thermal conductivity measurement:

400-500nm spatial resolution : 3% average precision

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