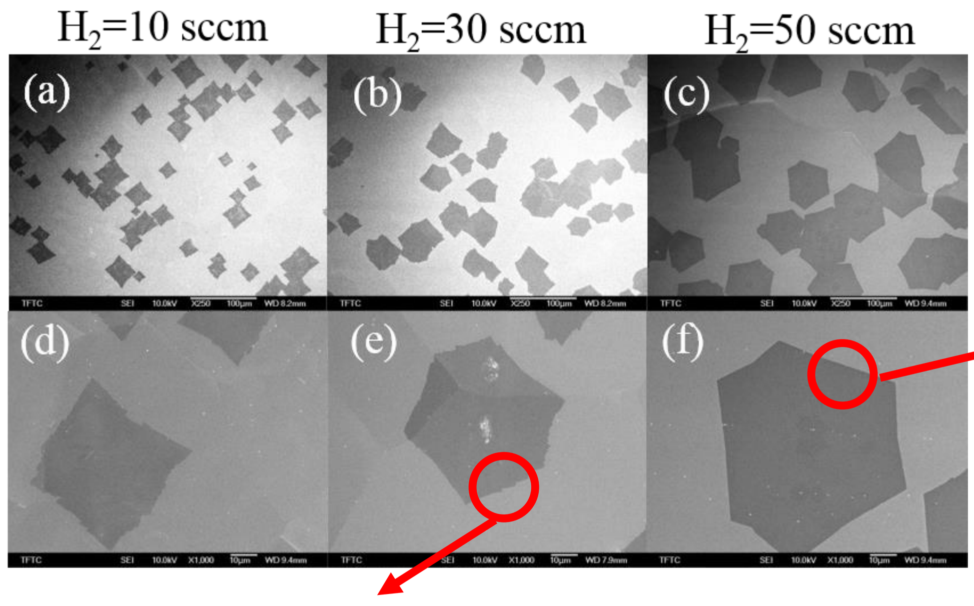
Derivation of approximately model for CVD graphene growth

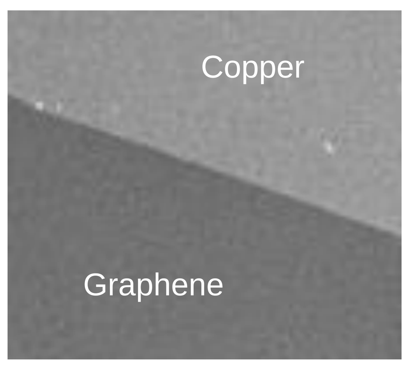
Shih-Hao Chan[1,2], Jia-Wei Chen[1,2], Sheng-Hui Chen[1,2], Chien-Cheng Kuo[1,2,3]*
[1]Thin Film Technology Center , National Central University, Chung-Li (32001), Taiwan
[2]Department of Optics and Photonics, National Central University, Chung-Li (32001), Taiwan
[3]Graduate Institute of Energy Engineering , National Central University, Chung-Li (32001), Taiwan
*cckuo@ncu.edu.tw

The aim in this study is controlling the nucleation density of graphene seed, furthermore, pursuing a lower sheet resistance by reducing the quantity of grain boundaries. We developed a simple derivation of approximately model for graphene growth under different hydrogen flow rate, ranging from 10 to 50 sccm. The morphology of graphene edge was become smoother with a high concentration of hydrogen flow rate. The growth parameters, CH_4 and temperature, are 0.5 sccm and 1070°C with ambient chemical vapor deposition (APCVD). The lowest sheet resistance of single layer graphene was 310 Ω/□ and the average transmittance is 97.7 % between 350 -1000 nm wavelengths.

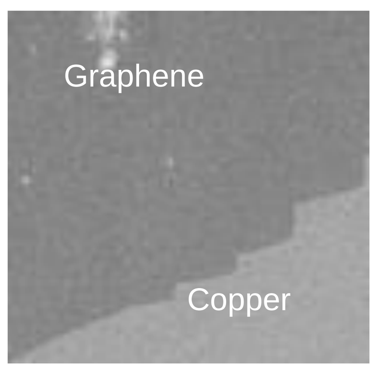
Coverage Area of Graphene Domains



Hexagonal Domain



Dendritic Domain

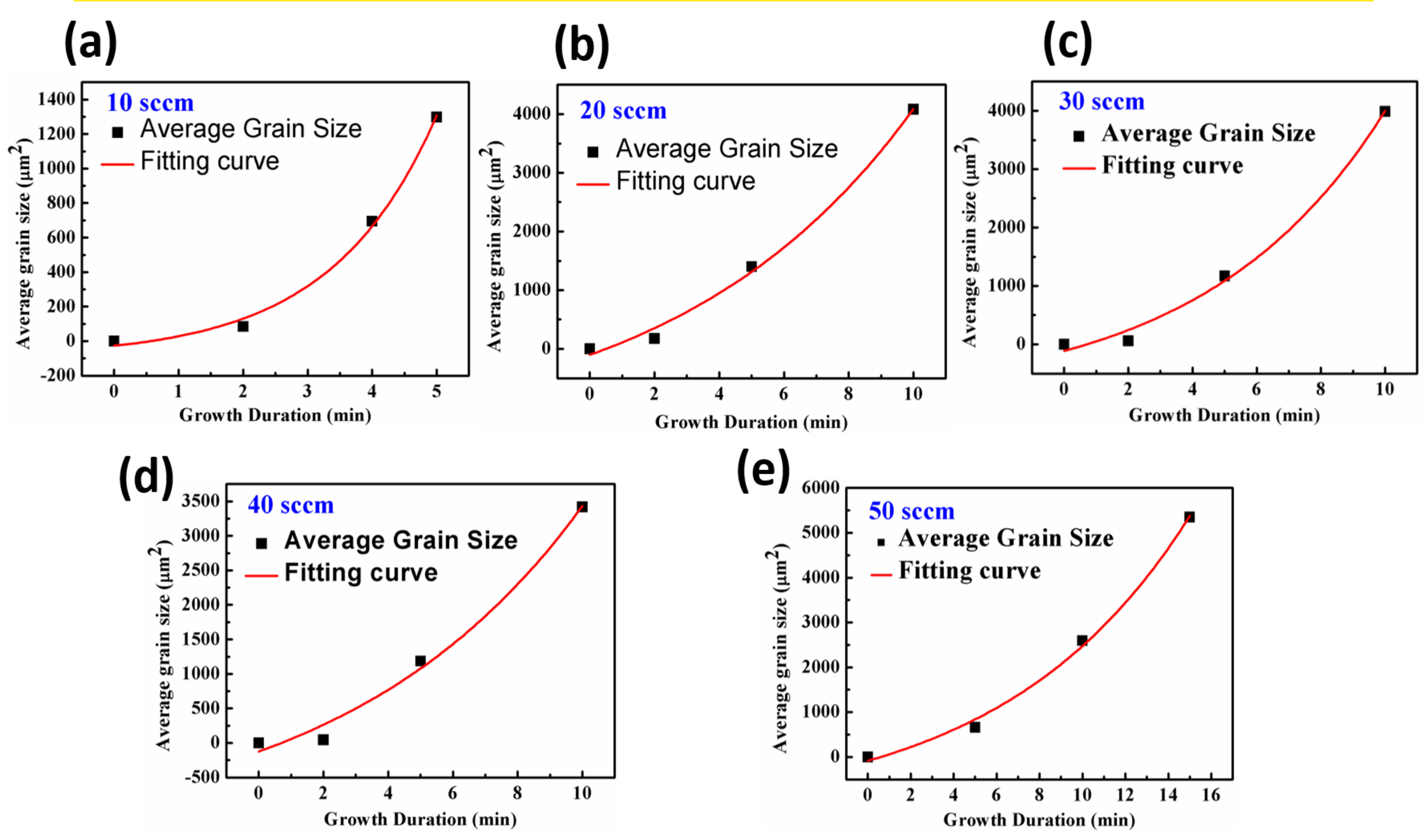


Hydrogen can etch the weak C-C and the C-H bond.

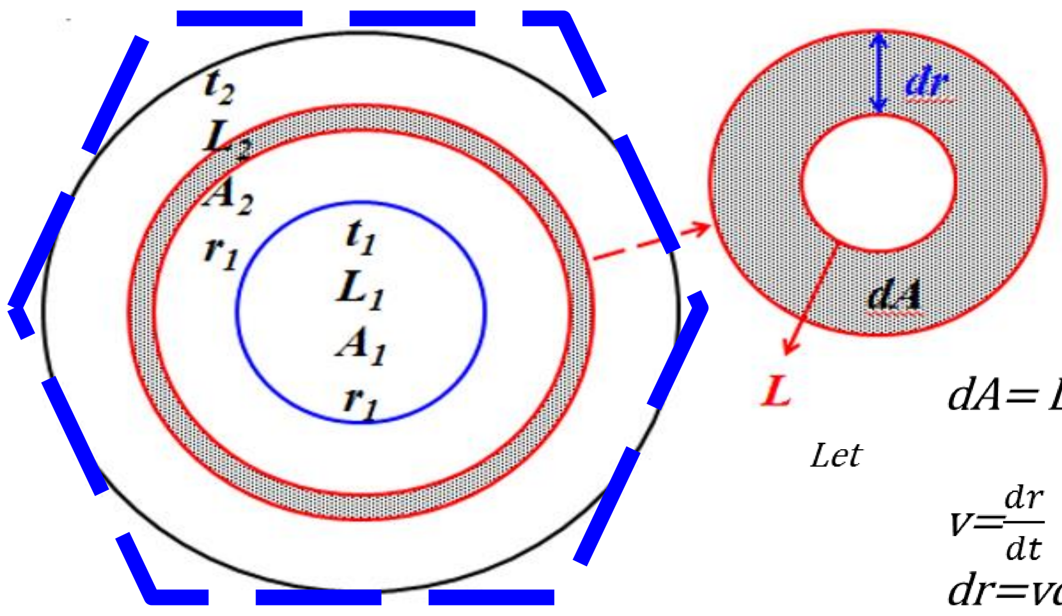
$$Graphene + C_xH_x(s) \leftrightarrow (Graphene - C_x) + yH(s)$$

H_2 flow rate (sccm)	10	20	30	40	50
Nucleation Density (μm^{-2})	3.22×10^{-4}	2.45×10^{-4}	2.33×10^{-4}	2.01×10^{-4}	1.72×10^{-4}

Carbon Growth Rate



Derivation of the Approximately model



$dA = Ldr$

Let

$v = \frac{dr}{dt}$

$dr = vdt$

And

$dA = Lvdt$

$L = (4\pi A)^{\frac{1}{2}}$

$(4\pi A)^{-\frac{1}{2}} dA = vdt$

$\frac{1}{2\pi}(4\pi A)^{\frac{1}{2}} = vt$

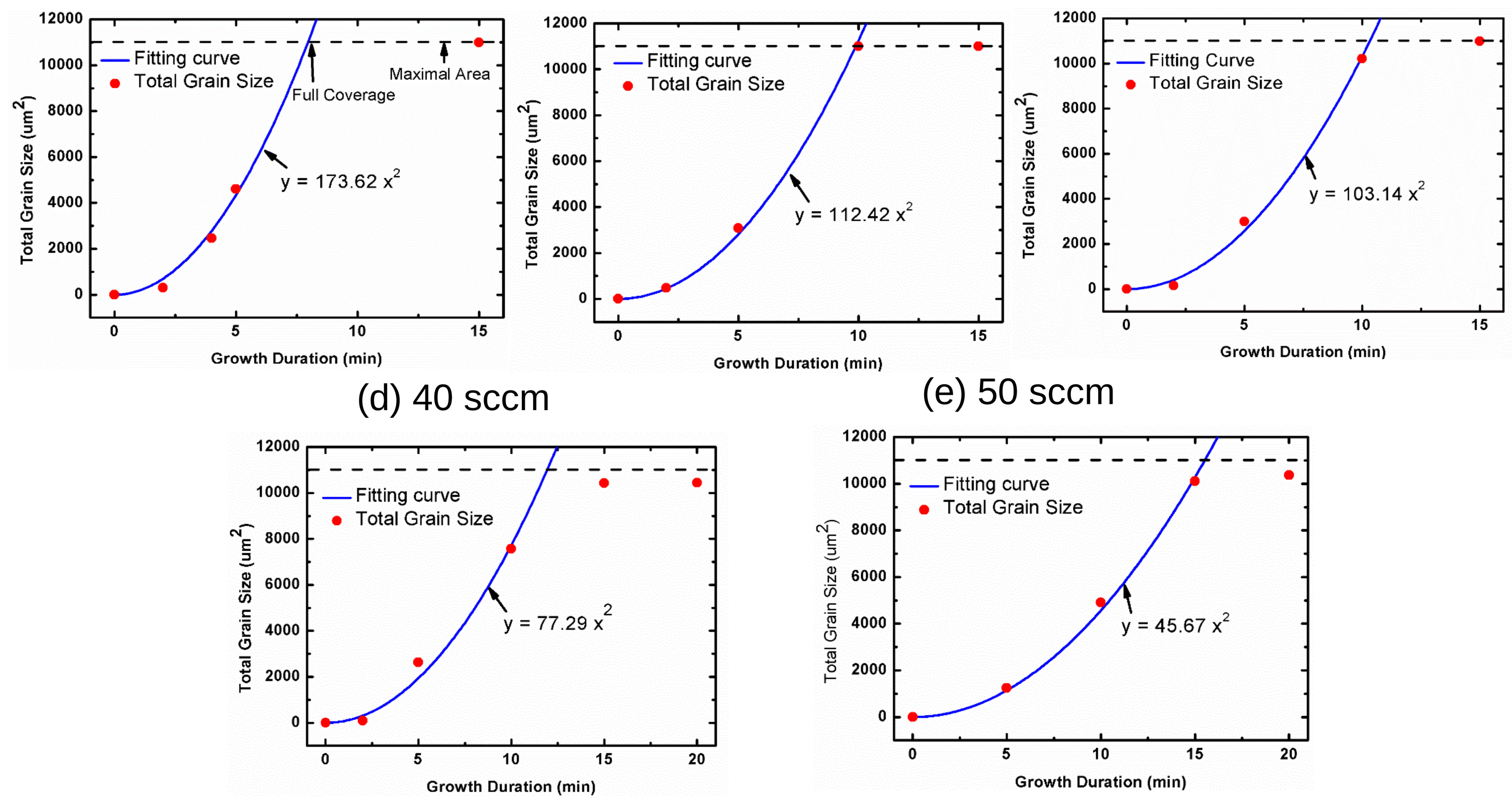
$A = \pi (vt)^2$

$A = \pi (vt)^2 = \frac{1}{2}\frac{d^2A}{dt^2}t^2$

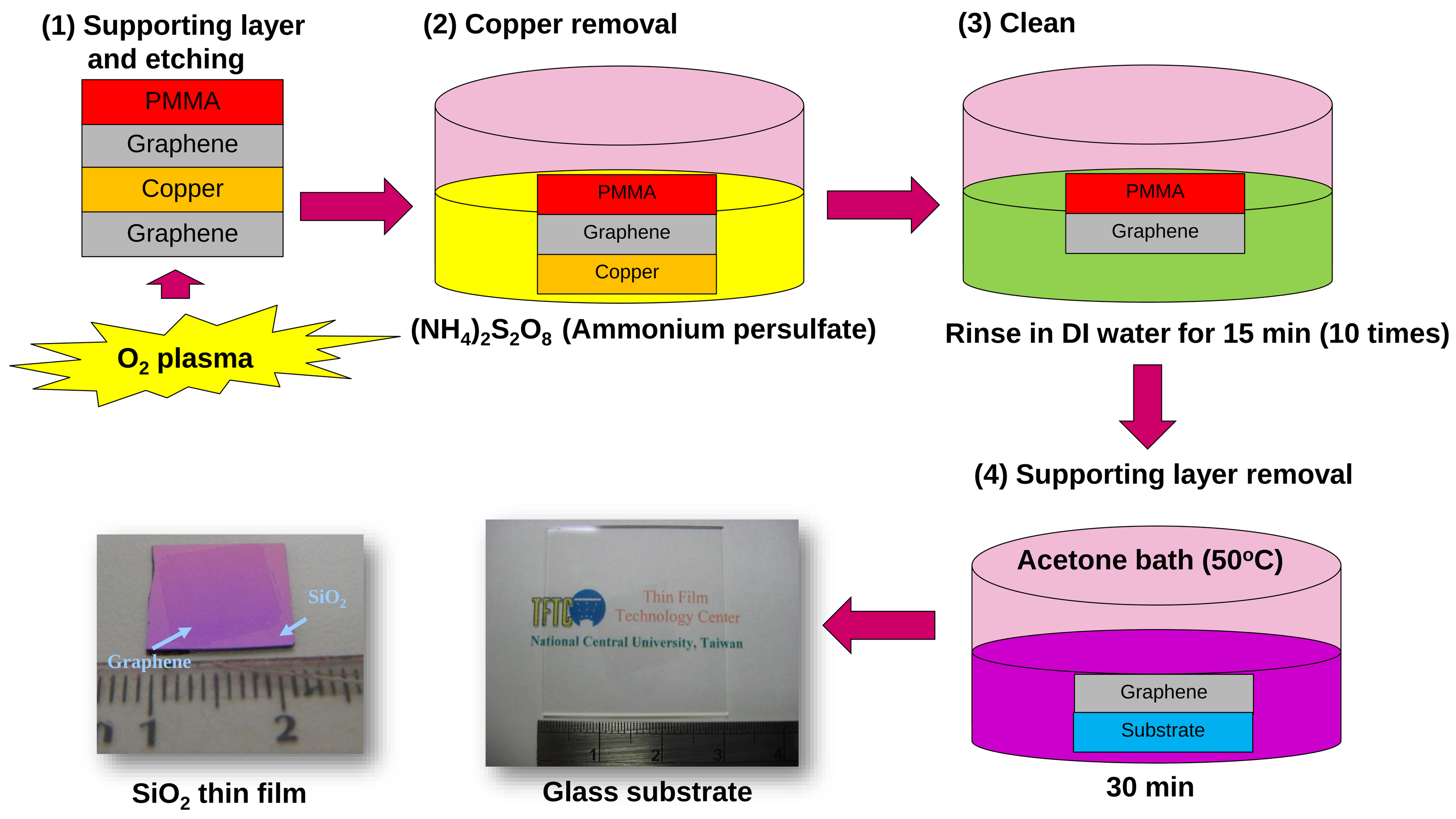
t = growth time
L= circumference
A= average araea
r = average radius

The average area is the second-order function of the growth time and growth rate of carbon atoms.

Coverage Area of Graphene Domains



Transfer Process



Summary