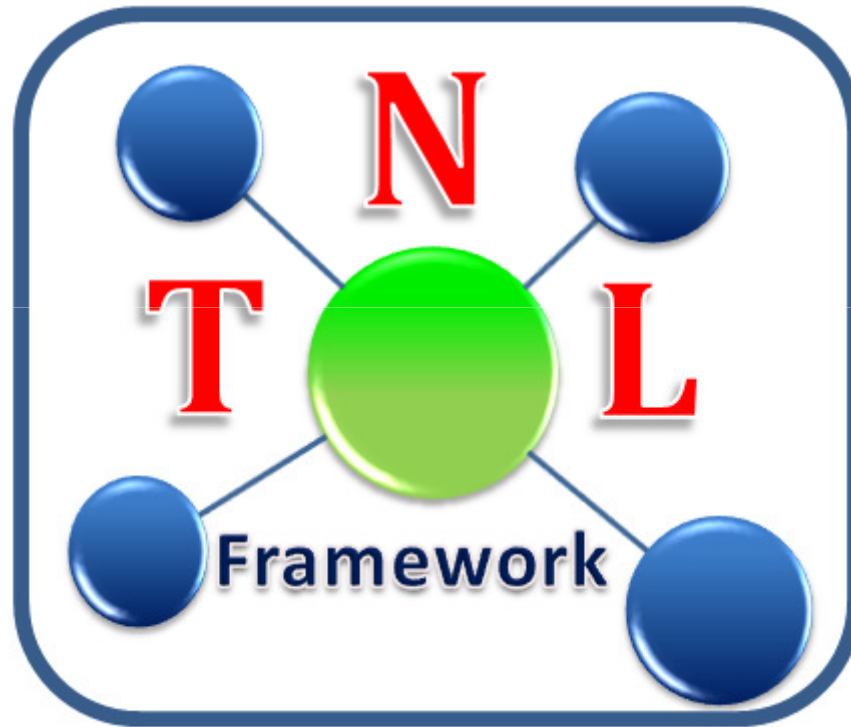
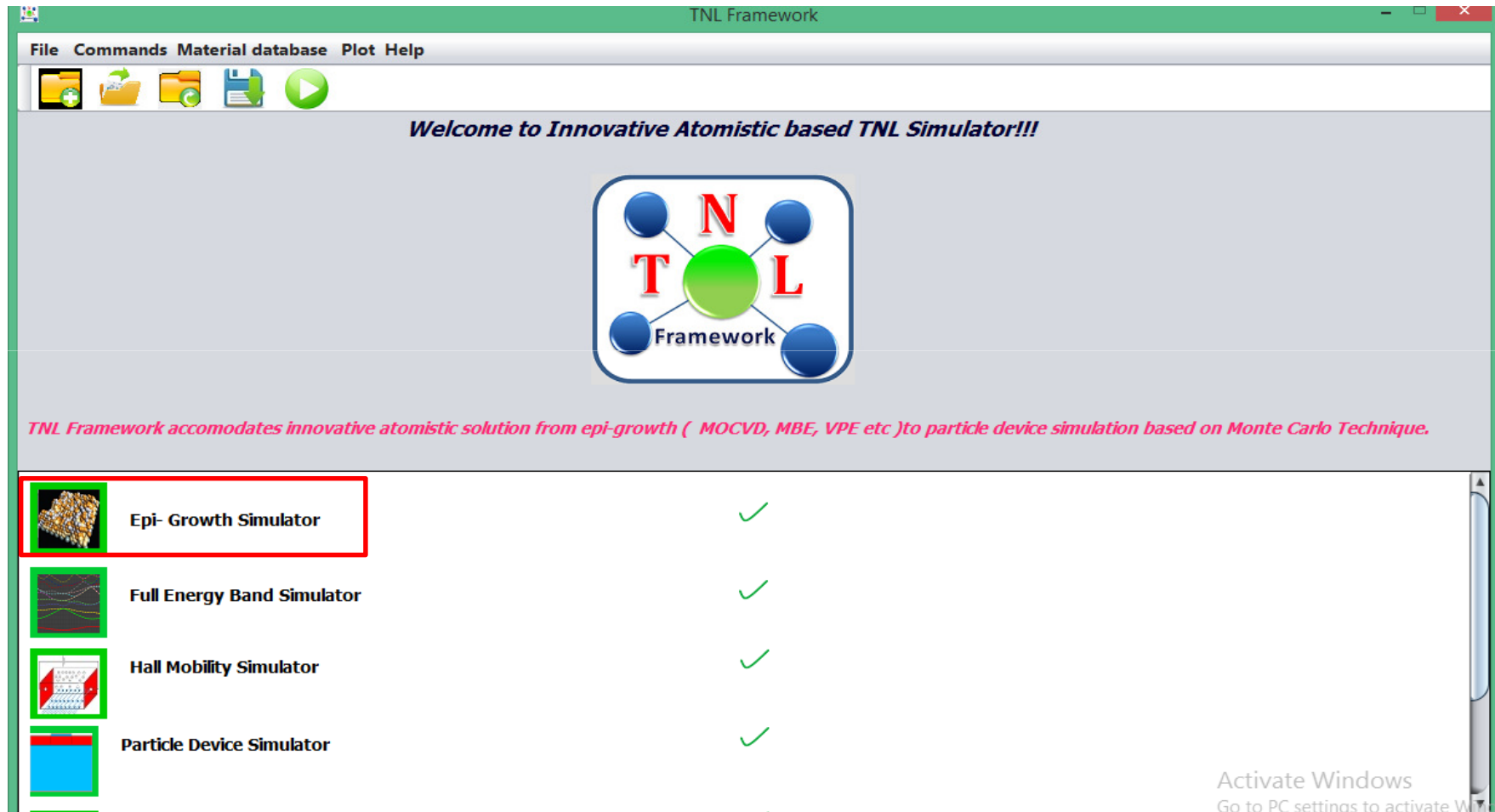


# Welcome to TNL Era



# TNL Framework



# EPI-Growth Simulator

- Epi-Growth Simulator consist two tabs.
- First is for providing Chamber Conditions.
- Second is for run output window.

The screenshot shows the Epi-Growth Simulator interface with two tabs: 'EpiGrow' and 'Run Output'. The 'EpiGrow' tab is active and contains the following fields:

- Substrate:** A dropdown menu labeled 'Select Substrate'.
- Orientation:** Radio buttons for 100, 001, and 111.
- Number of Steps:** A numeric input field with a value of 0.
- Substrate Domain:** Two empty text input fields.
- Time Interval for Roughness Calculation:** A label for the right-hand text input field.
- Time (sec):** A text input field.
- Temperature (C):** A text input field.
- Surface Energy (eV):** A text input field.
- Desorption Barrier Energy (eV):** A text input field.
- Schwoebel barrier (eV):** A text input field.
- Incorporation barrier (eV):** A text input field.
- Nearest Neighbour Attraction (eV):** A text input field.

Below these fields are two sub-tabs: 'Precursor Element' and 'Gaseous Elements'. The 'Gaseous Elements' tab is active and contains the following fields:

- Number of Precursor Elements:** A numeric input field with a value of 0.
- Precursor Elements Selected:** A text input field.
- Partial Pressure of Element (mbar):** A text input field.
- Sticking Coefficient of Element:** A text input field.
- Sigma:** A text input field with a value of 1E-20.

At the bottom of the 'Gaseous Elements' section is a 'Load Element Data' button. At the very bottom of the window are three buttons: 'RESET', 'ADD', and 'Run'.

# EPI-Growth Simulator

- In this tutorial we are going to grow AlGa<sub>N</sub> Over Silicon.
- Choose Silicon as a substrate.
- Orientation “100”.
- Number of process step “1”.
- Substrate domain “10”.
- For roughness calculation with time, It will calculate roughness each time it crosses the value given in the box “2”.

The screenshot shows the EPI-Growth Simulator interface. The 'Substrate' dropdown is set to 'Silicon'. A 'Select Substrate' dialog box is open, showing a list of substrates: Silicon, GaN, SiC-β-3C, Cd<sub>0.95</sub>Zn<sub>0.05</sub>Te, Cd<sub>0.7</sub>Zn<sub>0.3</sub>Te, Cd<sub>0.5</sub>Zn<sub>0.5</sub>Te, and GaAs. The 'Orientation' is set to 100, 'Number of Steps' is 0, and 'Substrate Domain' is 10. The 'Time (sec)' is 10, 'Temperature (C)' is 1000, 'Surface Energy (eV)' is 1.0, 'Desorption Barrier Energy (eV)' is 1.0, 'Schwoebel barrier (eV)' is 1.0, 'Incorporation barrier (eV)' is 1.0, and 'Nearest Neighbour Attraction (eV)' is 1.0. The 'Precursor Element' and 'Gaseous Elements' tabs are visible. The 'Number of Precursor Elements' is 0, and the 'Select Element' button is highlighted. The 'Precursor Elements Selected' field is empty. The 'Partial Pressure of Element (mbar)' is 1E-20. The 'Sticking Coefficient of Element' is 1E-20. The 'Sigma' field is empty. The 'Load Element Data' button is visible. The 'RESET', 'ADD', and 'Run' buttons are at the bottom.

# EPI-Growth Simulator

- After setting Substrate parameter new we are going to set growth conditions.
- Set time **10 sec**
- Temp **850 °C**
- Surface Energy **2eV**
- Desorption Barrier Energy **4eV**
- Schwoebel Barrier **0.02eV**
- Incorporation barrier **0.04eV**
- Nearest neighbour Attraction **0.02eV**.

The screenshot shows the EPI-Growth Simulator interface with the following parameters set:

Parameter	Value
Substrate	Silicon
Orientation	100
Number of Steps	0
Substrate Domain	10
Time Interval for Roughness Calculation	1
Time (sec)	10
Temperature (C)	850
Surface Energy (eV)	2
Desorption Barrier Energy (eV)	4
Schwoebel barrier (eV)	0.02
Incorporation barrier (eV)	0.04
Nearest Neighbour Attraction (eV)	0.02

Below the main parameters, there is a section for Precursor Elements and Gaseous Elements. The Precursor Element section shows:

Parameter	Value
Number of Precursor Elements	0
Precursor Elements Selected	
Partial Pressure of Element (mbar)	
Sticking Coefficient of Element	
Sigma	1E-20

Buttons at the bottom include RESET, ADD, and Run.

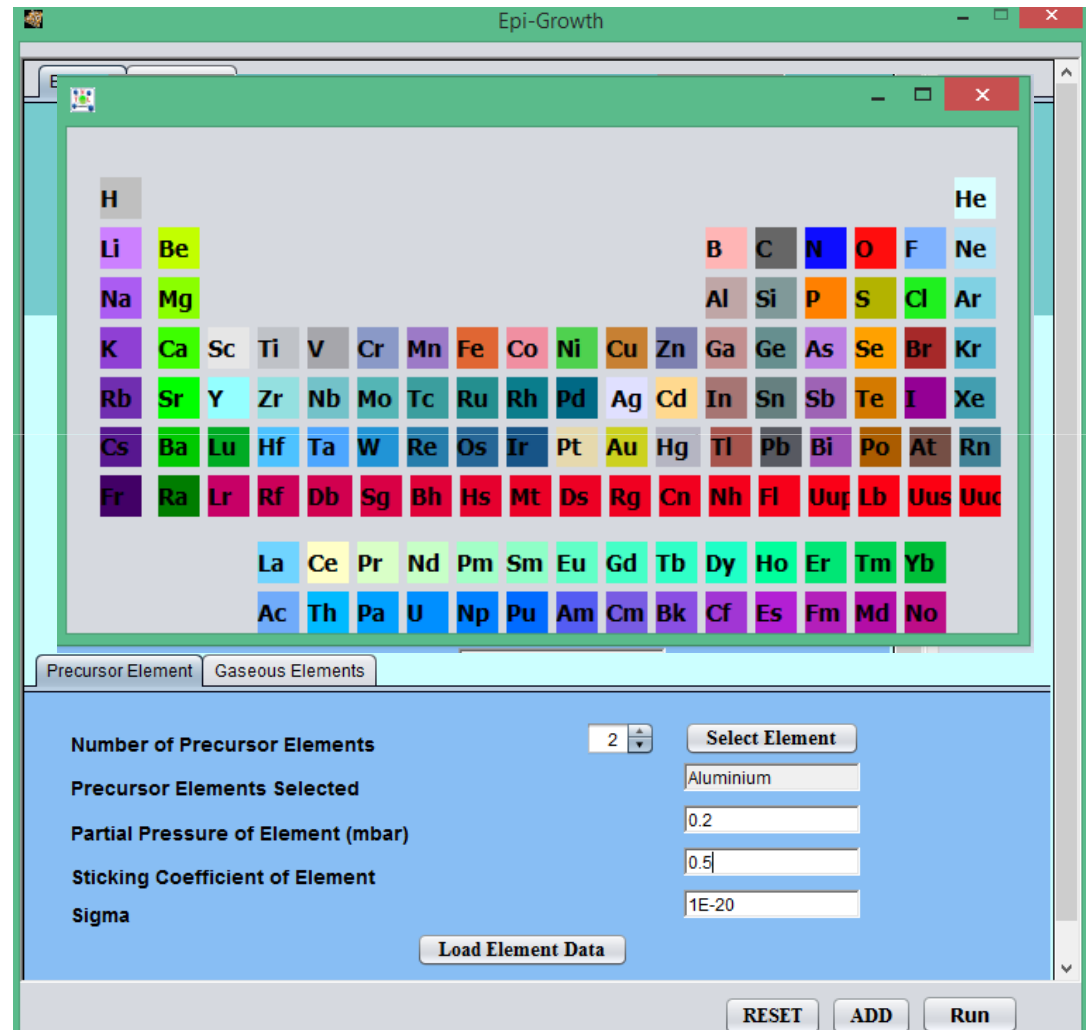
# EPI-Growth Simulator

- Now we going to provide precursors.
- Choose number of precursors Elements 2.
- Click on Select Elements
- It will open periodic table as shown in figure.
- Choose **Gallium** as first precursor.
- Partial pressure for Gallium **0.3 mbar**
- Sticking Coefficient **0.5**.
- Sigma **1E-20**
- Click on **Load Element Data** button.



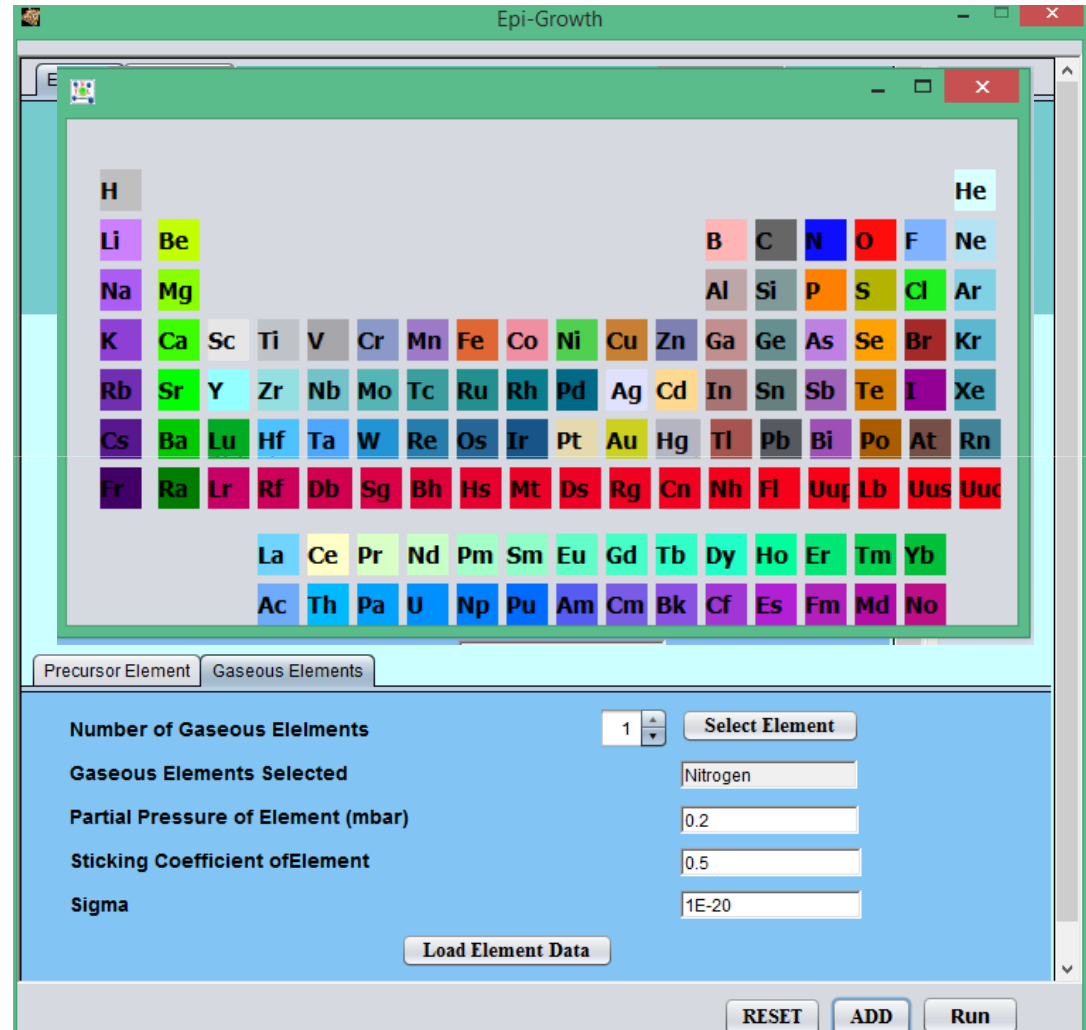
# EPI-Growth Simulator

- Now we going to second provide precursors.
- Click on Select Elements
- It will open periodic table as shown in figure.
- Choose **Aluminium** as Second precursor.
- Partial pressure for Gallium 0.2 mbar
- Sticking Coefficient 0.5.
- Sigma 1E-20
- Click on **Load Element Data** button.



# EPI-Growth Simulator

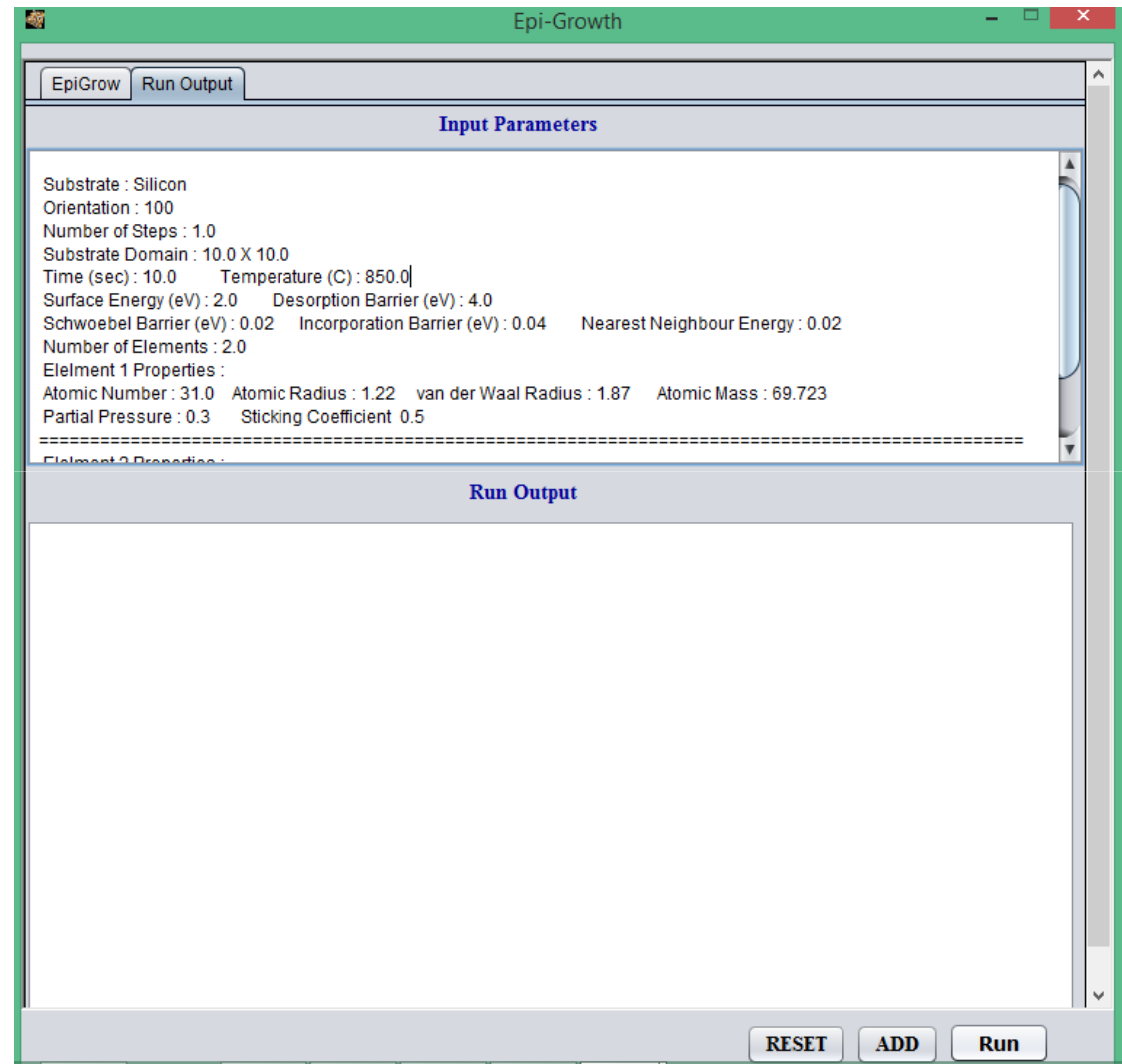
- Now we going Add Gaseous Element.
- Choose Number of Gaseous Element **1**.
- Click on Select Elements
- It will open periodic table as shown in figure.
- Choose **Nitrogen** as Abundance.
- Partial pressure for Gallium **0.8 mbar**
- Sticking Coefficient **0.5**.
- Sigma **1E-20**
- Click on **Load Element Data** button.
- Now at last click on **ADD** button.





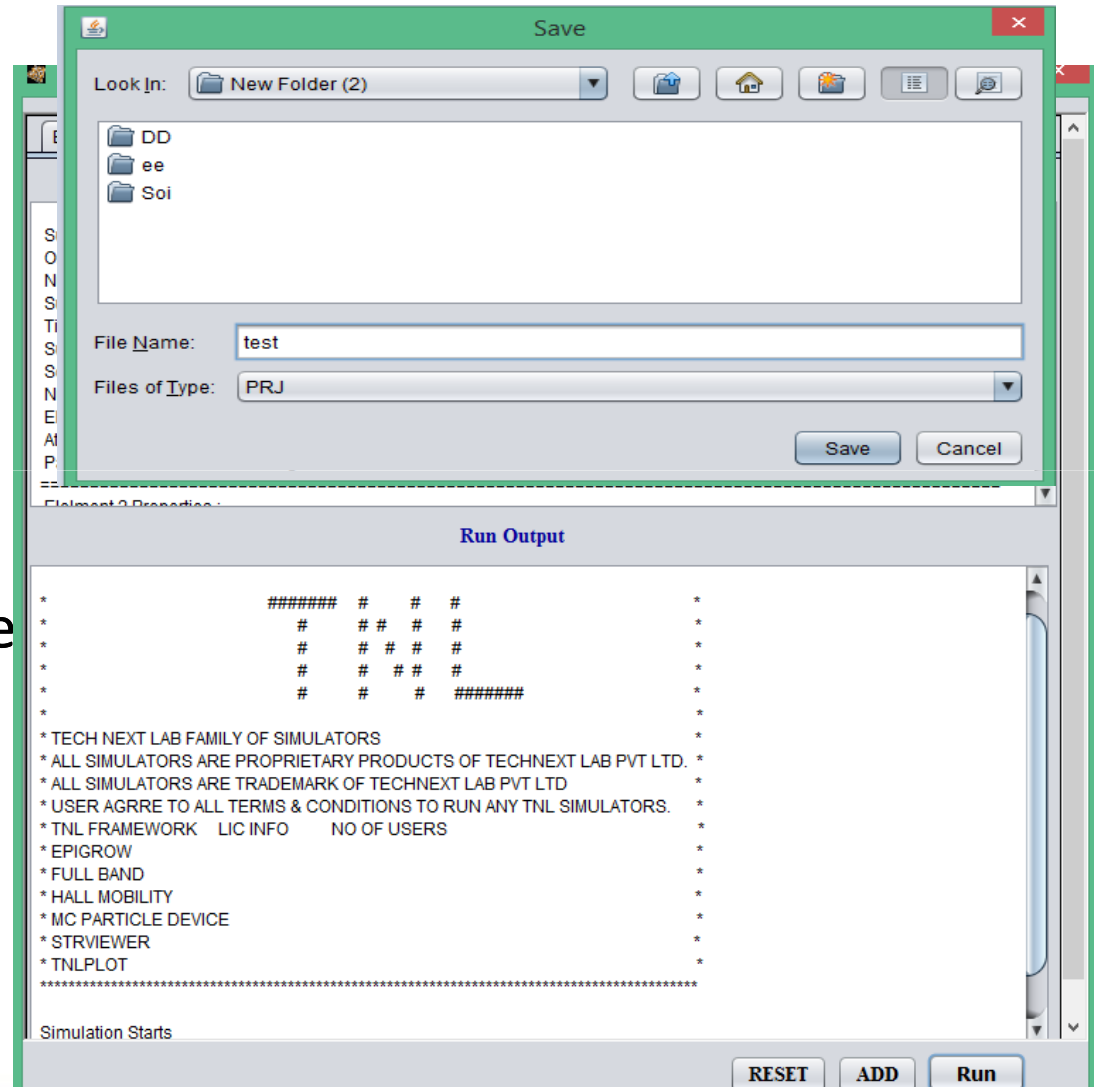
# EPI-Growth Simulator

- Once we click ADD button almost all field will be empty on **EpiGrow** window.
- Switch to **Run Output**
- In the top side (Input Parameter) we can see all values we have provided to simulate.
- Now click on **Run** button.



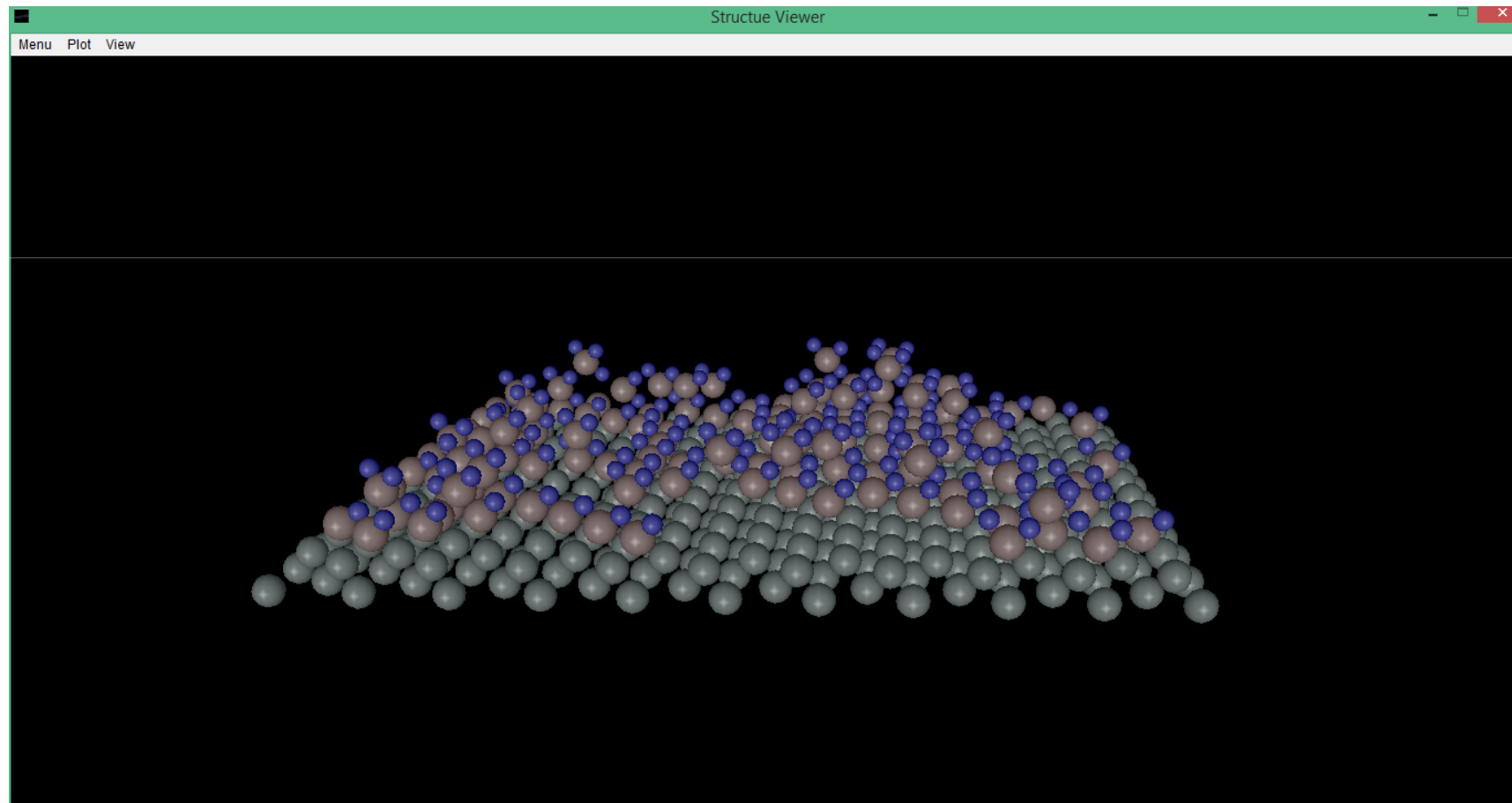
# EPI-Growth Simulator

- Once we click on Run Button, it will ask for save project.
- Save it on suitable directory.
- Run Output window starts showing run time output.



# EPI-Growth Simulator

- Open StrViewer from TNL Frame work.
- Click on open button from Menu bar. Go to project Directory Open “RPM.str”.



# EPI-Growth Simulator

- Open TNL plot from TNL Frame work.
- Click on open button from Menu bar. Go to project Directory Open “**Roughness.plot**”.

