

Inhomogeneity of Resist Film Simulated by Molecular Dynamics

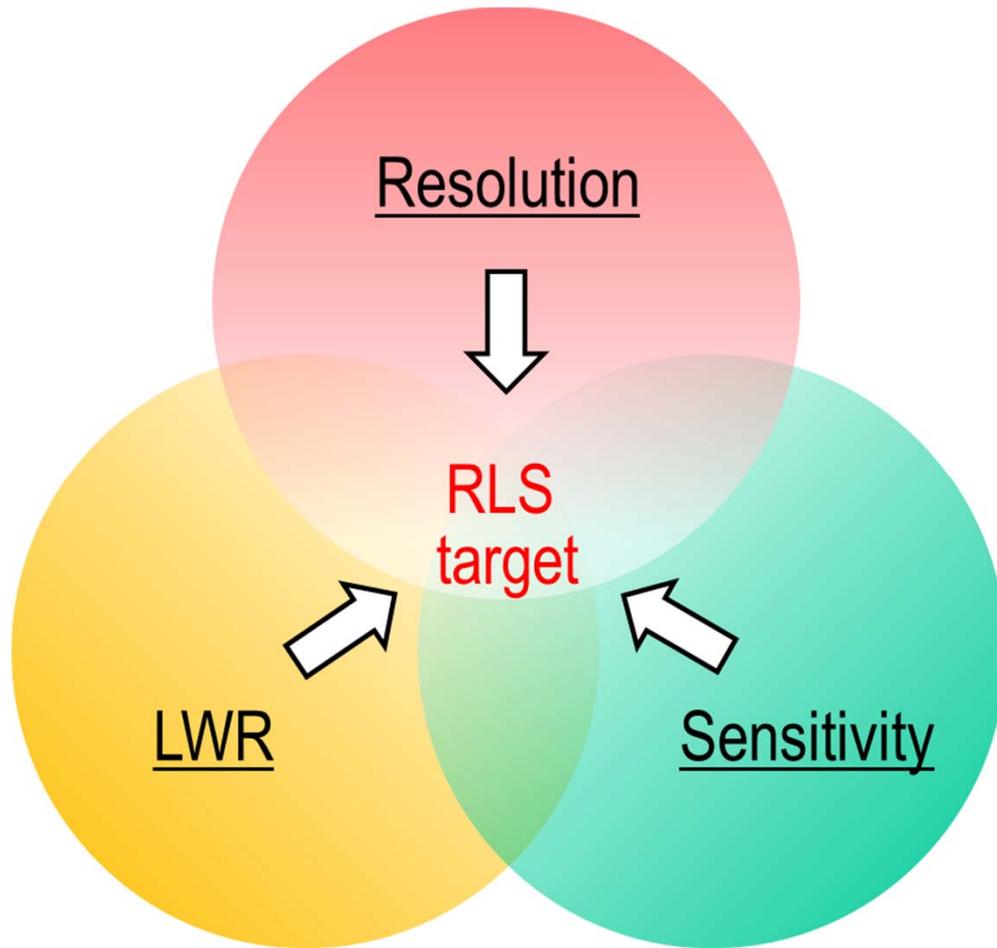


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Outline

- Introduction
 - RLS, Inhomogeneity
 - Molecular Dynamics(MD)
- MD Simulation
 - Force fields
- Inhomogeneity
 - PAG localization
- Mesoscopic simulation
 - Simulation of development process
- Summary

Introduction / RLS and related causes



Optical properties

Acid generation properties

Development properties

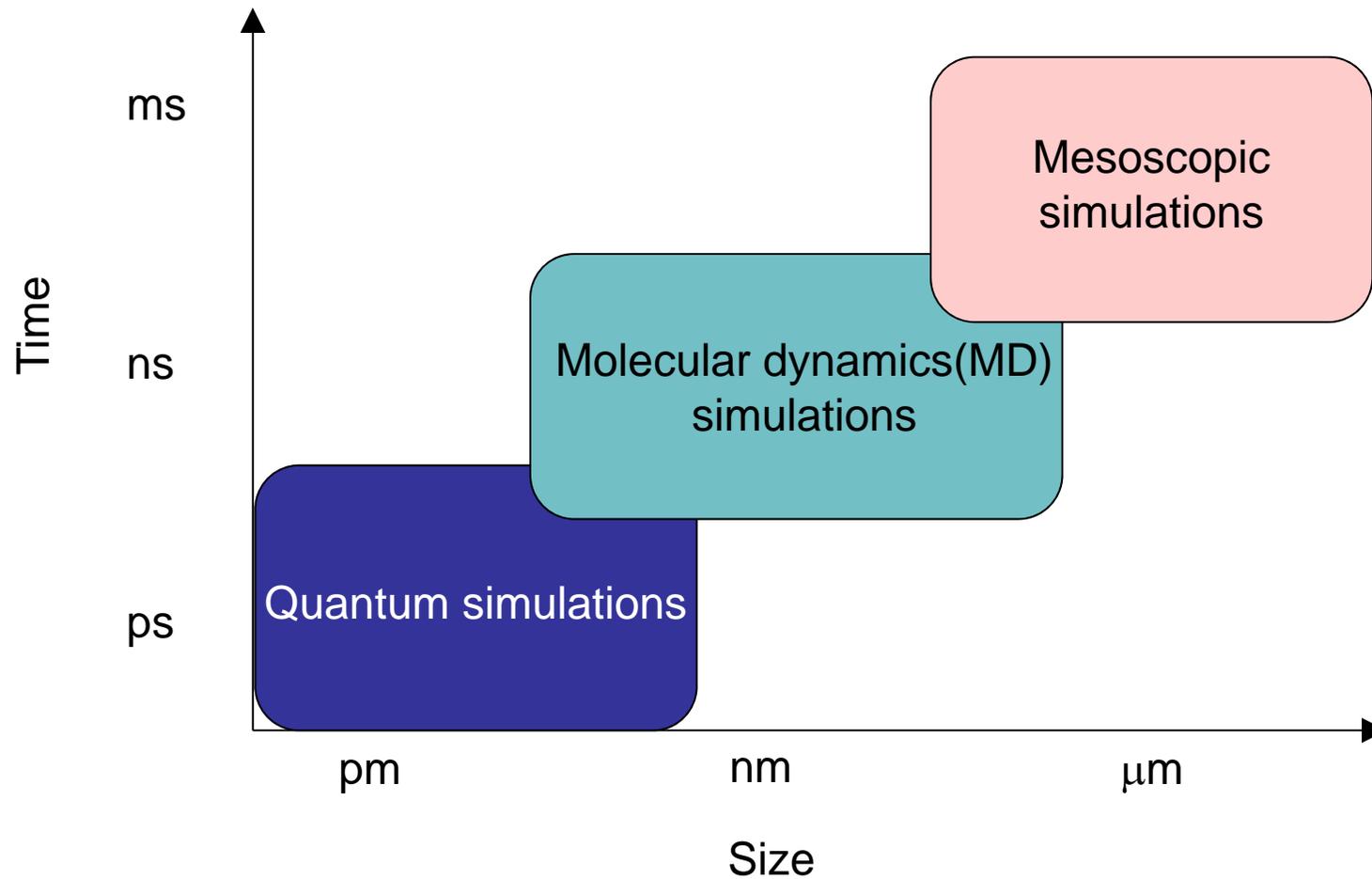
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Inhomogeneities of PAGs

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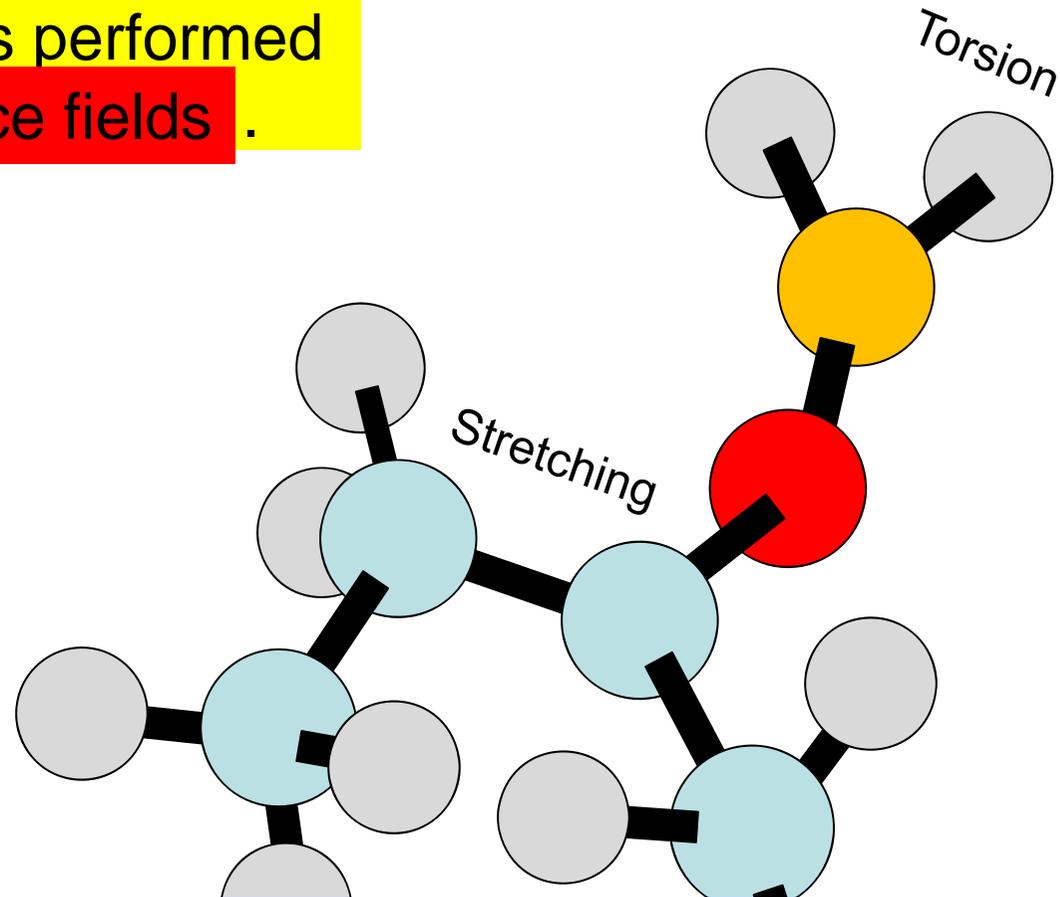
Molecular simulations

Simulation methods and Scales of time & space



MD Simulation / Principle of MD simulation

MD simulation is performed based on **force fields**.

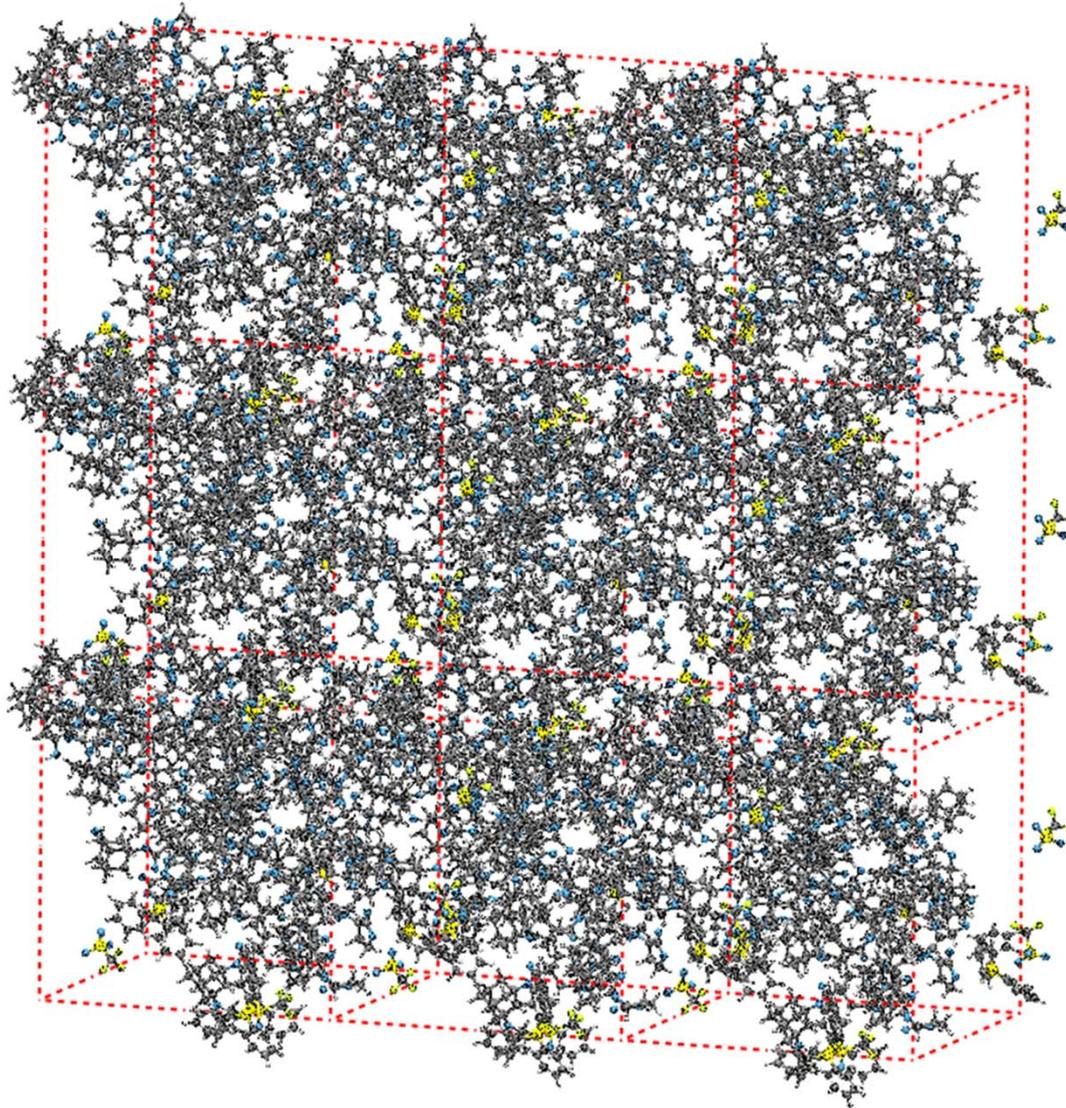


Force fields custom-made for resist simulations

are extended to more PAGs.

Rotation

Resist model for simulations



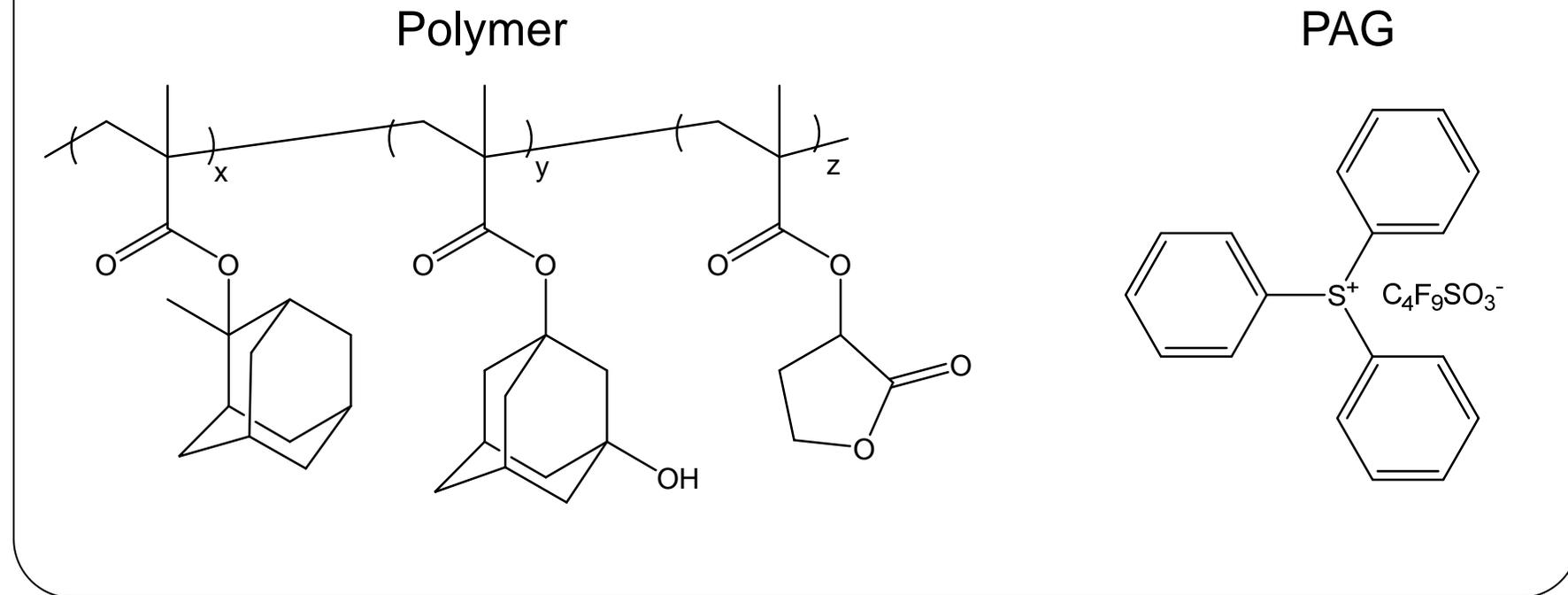
“Amorphous cell”
3D periodic structure



Resist film

Experimental : EUV model resist

EUV model resist simulated by MD

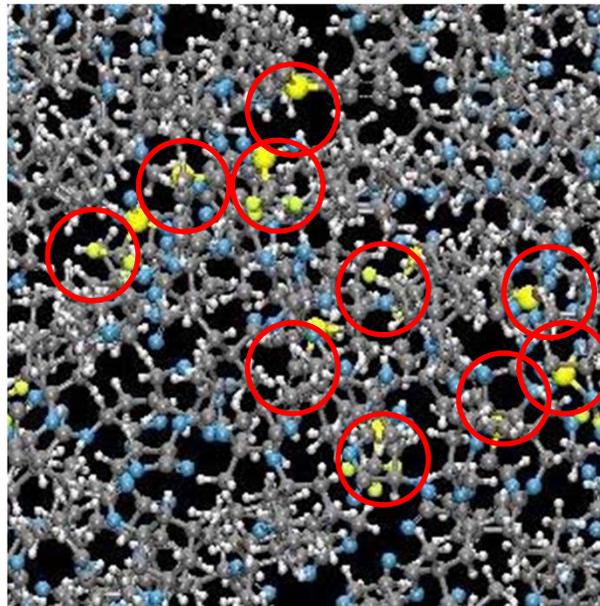


MD simulator
SciMAPS (SCIENOMICS, Inc.)
LAMMPS

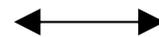
Inhomogeneity of PAGs



PAG anion : CF_3SO_3^-



 Polymer


1 nm

Inhomogeneity of PAGs



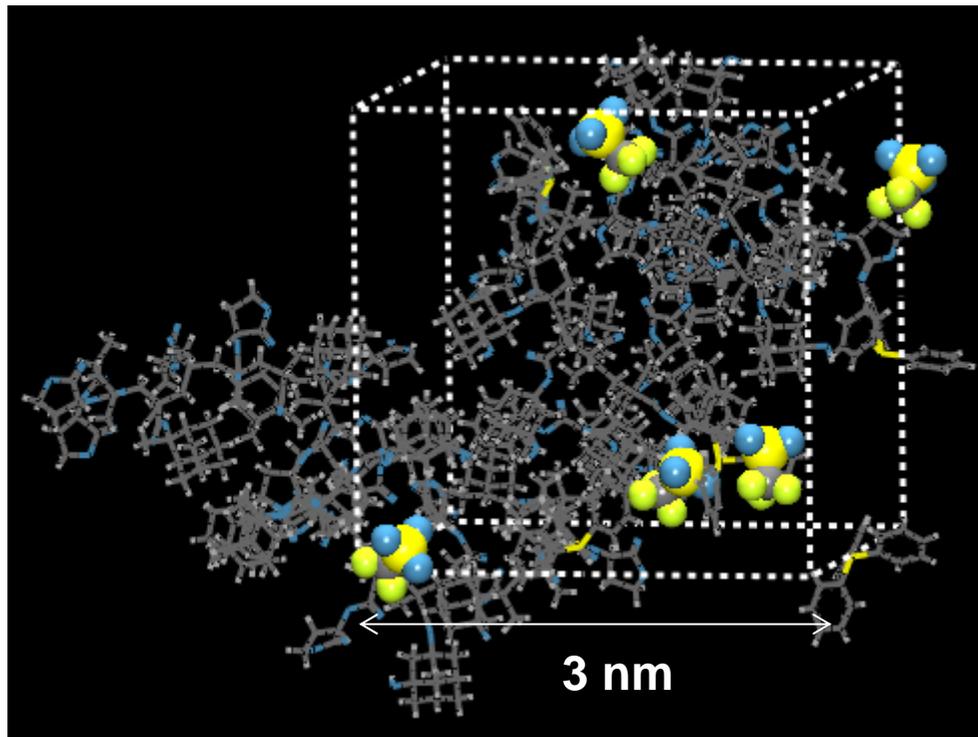
Resolution
LER/LWR
Sensitivity

...

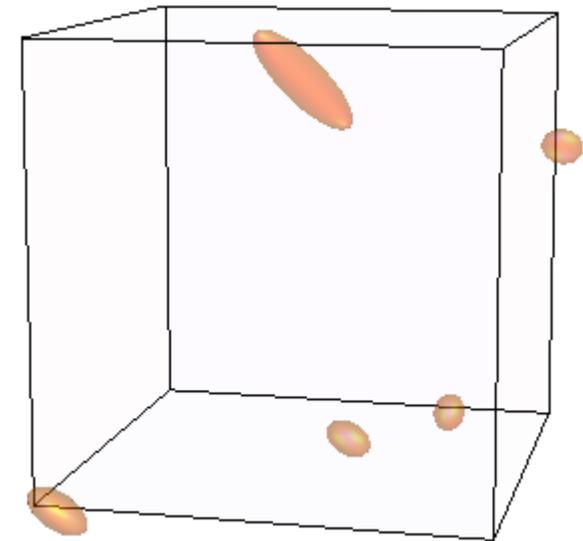
PAGs show the inhomogeneous distribution.

3D distribution of gravity-center trajectory of PAG anion

PAG anion :  CF_3SO_3^-



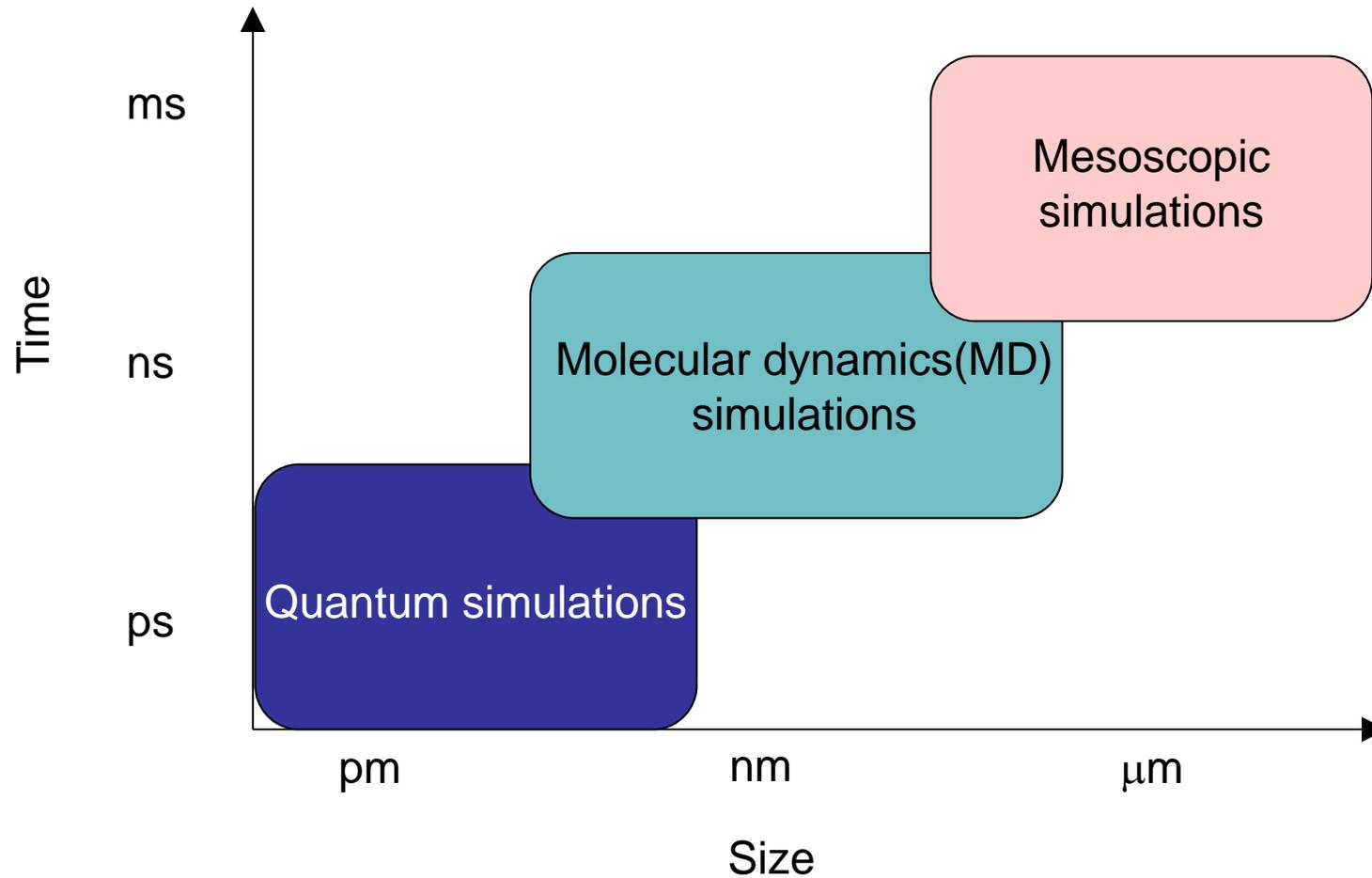
3D distributions of
PAG-anion trajectory



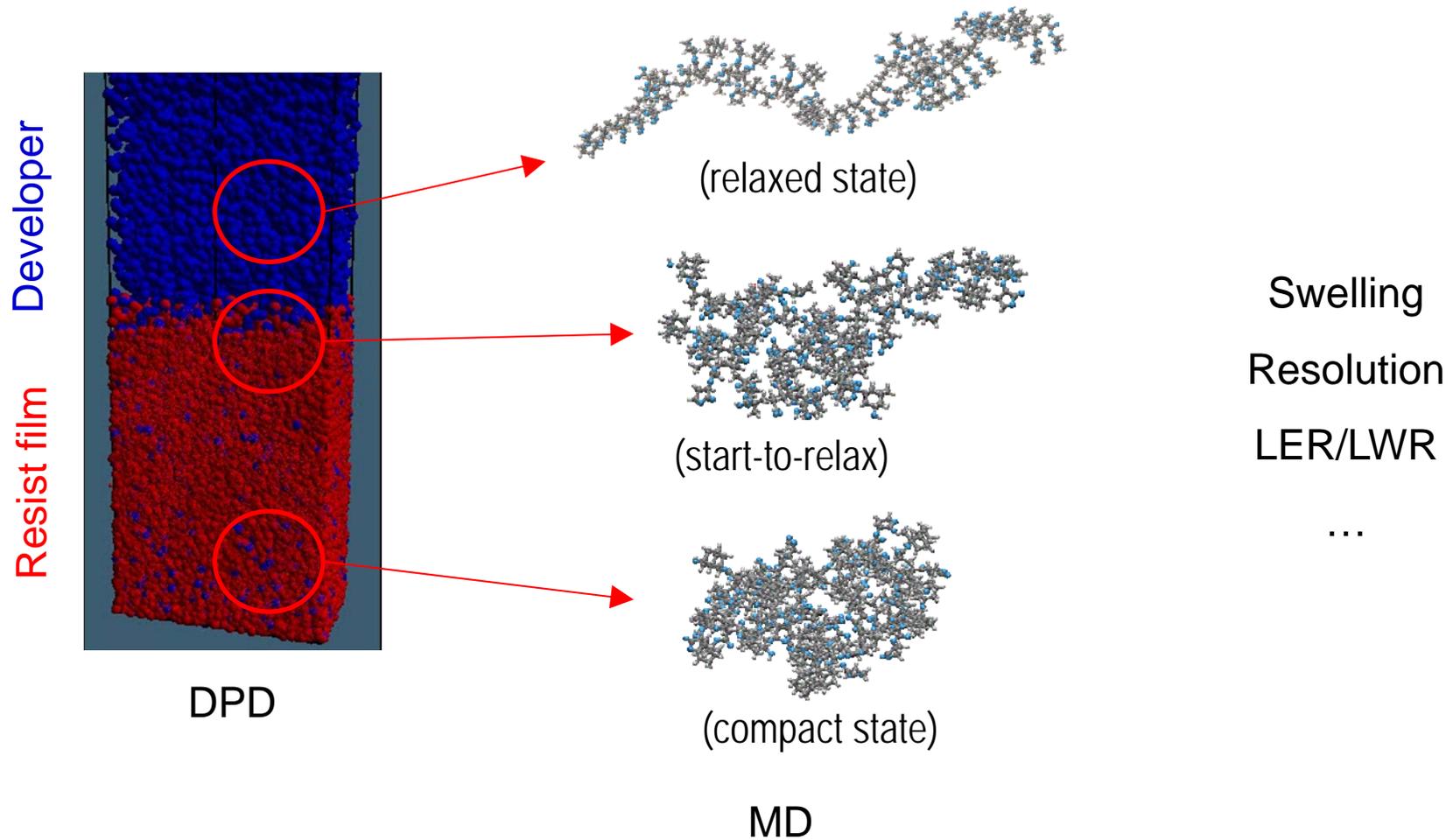
[to:Mathematica](#)

Each PAG shows specific regions of trajectory.

Introduction / Simulation methods and Scales of time & space



Mesososcopic simulation / Simulation of Development process



Summary

- **Molecular Dynamics (MD) simulation** has been evaluated and utilized to study the atomistic information on resist materials.
- **MD simulation was performed with special force fields for resist materials.** Force fields for PAGs are available.
- **PAG inhomogeneity in resist film** was started to be evaluated. Individual PAGs show specific motions, of which trajectories are influenced by **free volumes** and (probably) chemical properties of resist.
- **Development process** is currently being investigated by **Mesosopic simulation**.

Further studies on inhomogeneity of PAG, base resins and functional groups by MD simulations are in progress.

Acknowledgements

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