Synthesis of molecular thinfilms for photovoltaics

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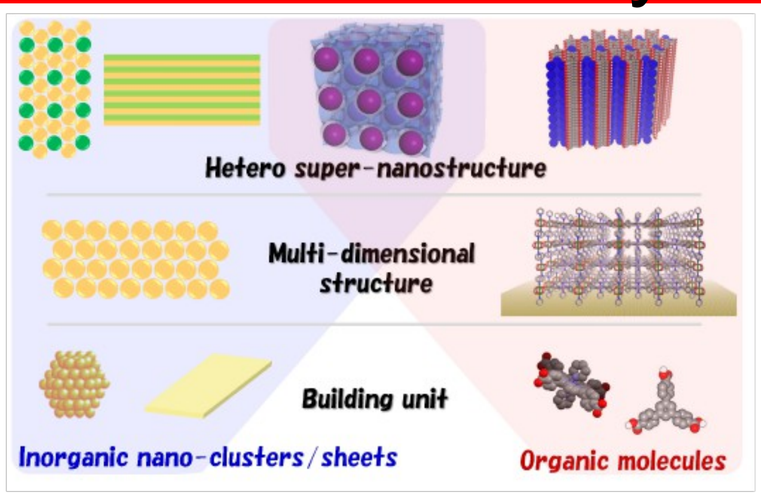
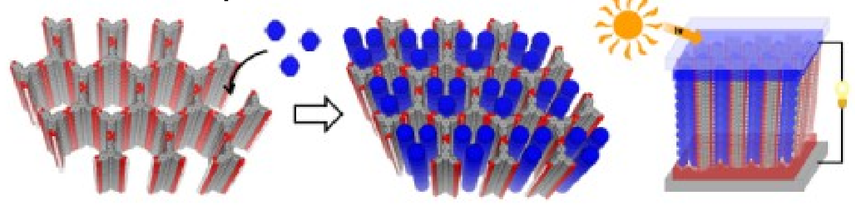
Makiura Laboratory Research : Creation of hetero nanostructures

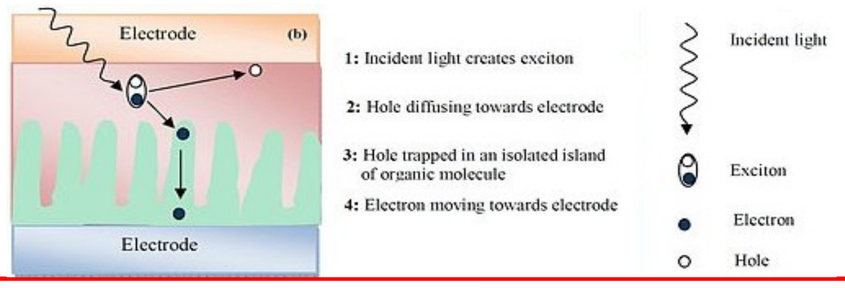


Makiura Laboratory Web page : http://www.nanosq.21c.osakafu-u.ac.jp/ttsl_lab/r_makiura/research/en_index.html

- Use of nano scale materials: unique properties
- Bottom up synthesis such as self-assembly of nano-sheets then creation of multi-dimensional structures
- Application in energy related issues such as batteries or organic photovoltaic cells: Creation of porous network and insertion of molecules to create a p-n junction

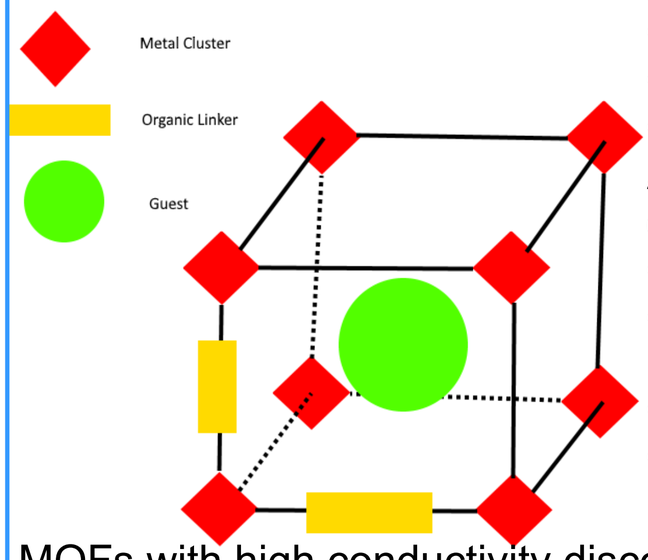


- Increase the p-n interface surface area = Better charge separation



- Creation of path for carriers = Improved conductivity

Research subject: Synthesis of metal-organic frameworks (MOFs) thinfilms



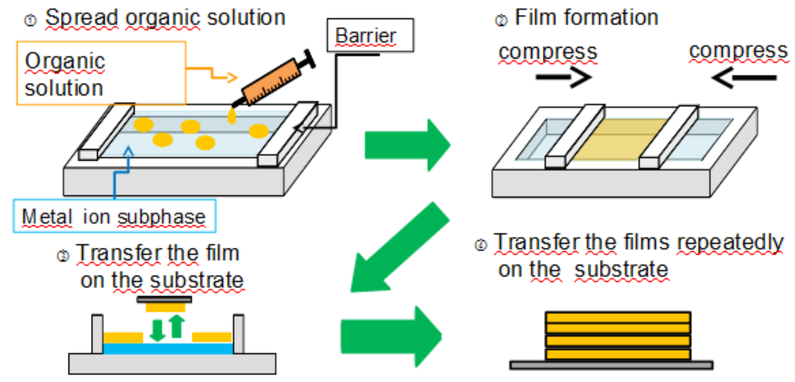
Advantage of organic chemistry:
- Lightness
- Flexibility
- Design

Advantage of inorganic chemistry:
- Thermal resistance
- Durability

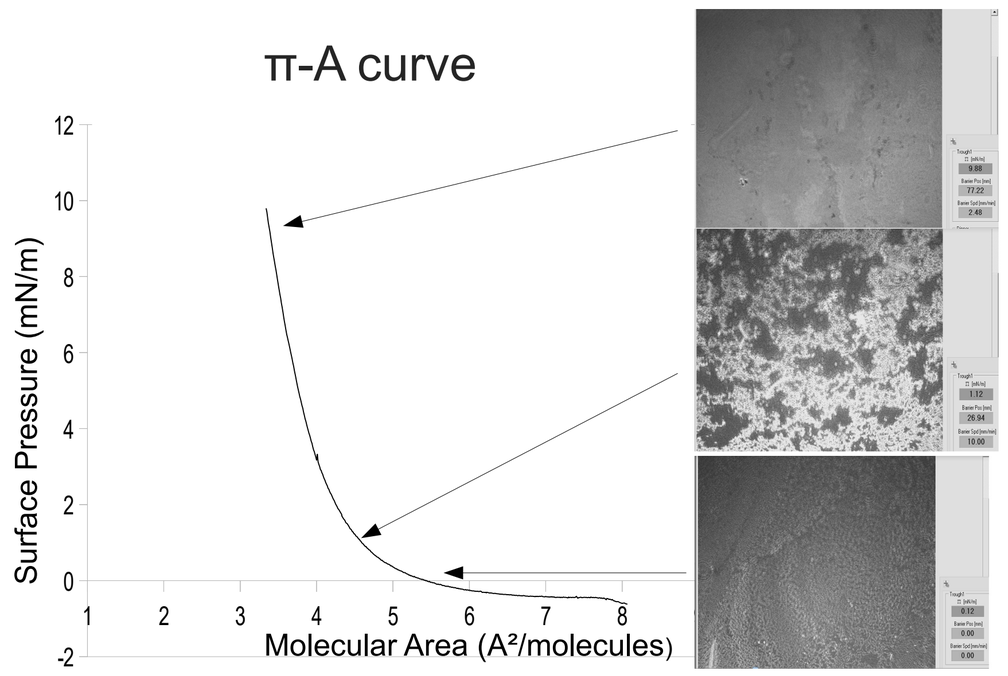
Porous materials:
- Catalysis
- Gas separation/ stockage/identification

MOFs with high conductivity discovered recently: potential use as **semiconductor**

Protocol: Fabrication of Langmuir-Blodgett films and Layer-by-Layer deposition

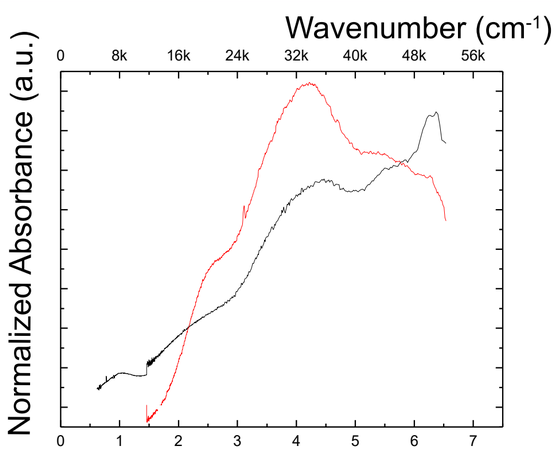


- Ligand dissolved in organic solution
- Aqueous solution contains Metal ion
- Growth of the film through iterative process

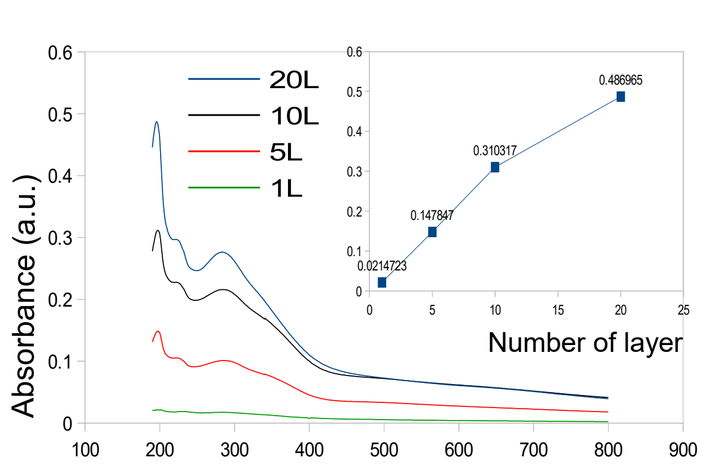


Metal-organic framework reaction synthesis occured or mere aggregation of the ligand?

Analysis of the films



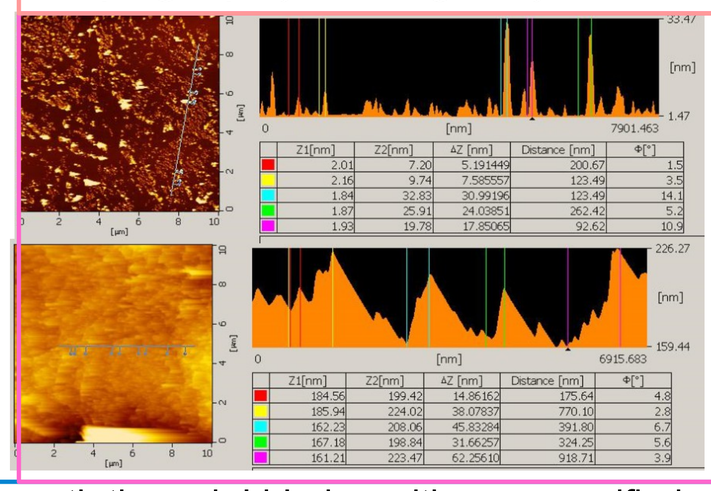
Apparition of novel peaks at high energy, coming from Charge Transfer between ligand and metal



absorbance increases proportionally with the amount of layer in a proportional way

Coordination of organic ligand with metal is proven through the apparition of **Charge Transfer** and **control of the growth** of the thin film through LbL is validated with **Beer-Lambert law**

Topography through Dynamic Force Microscopy



	Z1[nm]	Z2[nm]	ΔZ [nm]	Distance [nm]	Φ[°]
	2.01	7.20	5.191449	200.67	1.5
	2.16	9.74	7.585557	123.49	3.5
	1.84	32.83	30.99196	123.49	14.1
	1.87	25.91	24.03851	262.42	5.2
	1.93	19.78	17.85065	92.62	10.9

	Z1[nm]	Z2[nm]	ΔZ [nm]	Distance [nm]	Φ[°]
	184.56	199.42	14.86162	175.64	4.8
	185.94	224.02	38.07837	770.10	2.8
	162.23	208.06	45.83284	391.80	6.7
	167.18	198.84	31.66257	324.25	5.6
	161.21	223.47	62.25610	918.71	3.9

1L Growth of the layer can constated through the difference of height between the 1L and 40L 40L thin films.

Conclusion

- Fabrication of metal-organic frameworks thin films were realized, control of the growth through LbL deposition was verified and analysis of the thin films were done using UV-vis spectroscopy, IR-spectroscopy, X-Ray Diffraction, Dynamic Force Microscopy and Cyclic Voltammetry.
- Internship in a country like Japan was more difficult than I thought as culture greatly differ from western countries. Very high autonomy is expected. But the internship in itself was very fun, laboratory co-workers and japanese in general are nice and highly increased my level in the language.
- One advice I can give to all next student doing research is to always list with order their results, the time gained is incredible on the long range.