Orchestrating a brighter world

NEC

NeCycle

NEC develops non-edible-plant-based bioplastic featuring elegance of traditional Japanese lacquerware

- *”Urushi black” bioplastic* -

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Development of Japanese lacquerware-like “Urushi black” bioplastic

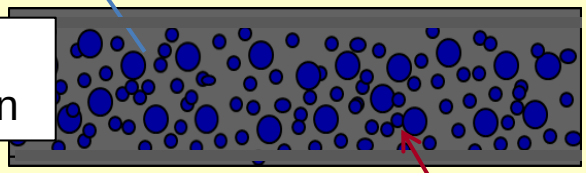
NEC has developed a new cellulose-type bioplastic featuring high decorativeness of traditional Japanese lacquerware, which will be applied to high-value added products requiring environmental friendliness and high decorativeness

A top level Japanese lacquerware
(by Dr. Yutaro Shimode)

“Urushi black” bioplastic

Cellulose resin based on non-edible plant Resources (wood, stem)

Cross section

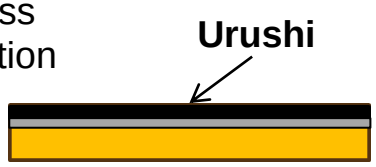


Special coloring agents

Appearance of test plate

Realizing “Urushi black”
(formed by injection molding.)

Cross section



Luxury cars
(interior components)

High class building material

High-grade electronics

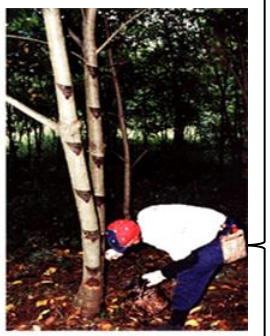
High class stationery, watch, etc.

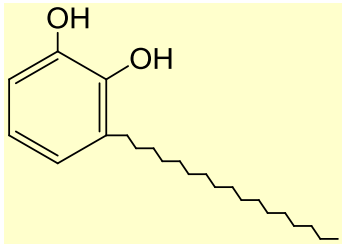
What is Urushi (Japanese lacquer) ?

- Urushi, a natural organic compound mainly consisting of urushiol (phenol resin derivative) is a highly decorative traditional painting material for goods and arts, especially progressed in Japan. Therefore, it is named as japan, Japanese lacquer or Urushi.
- Japanese lacquerware is an art work highly evaluated internationally. However, higher class ones require more effort to fabricate (repeated coating and polishing of lacquer), thus its mass production is difficult.

Preparation of Urushi and production of Japanese lacquerware

Natural Urushi



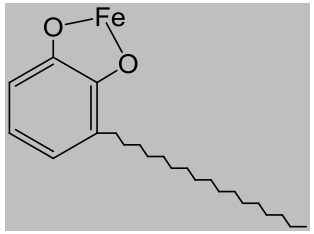


Urushiol

+ Impurity
  - Water
  - Elastomer
  - Protein

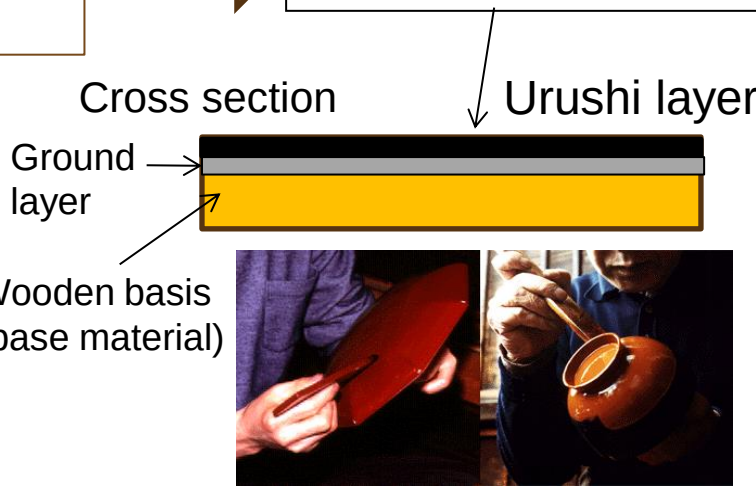
Homogenization, Filtration, Water reduction,
+ Mixing of additives (iron compound etc.)

→ Refining and coloring →



Urushiol iron

→ Painting and curing



→ Polishing

Collaborating lacquerware artist : Dr. Yutaro Shimode

- Dr. Shimode (Ph.D.) is a top-level lacquerware artist in Japan.
- He is the third-generation president of Shimode makie-studio and a professor at the Faculty of Cultural Studies of Kyoto Sangyo University.
- He has been producing many excellent Urushi arts, such as Makie in the national Kyoto guest house, etc. Recently, he reproduced the Urushi arts in Kodai-ji temple by adding his original excellent technologies.
- He received many national prizes and has been highly estimated in many international exhibitions.

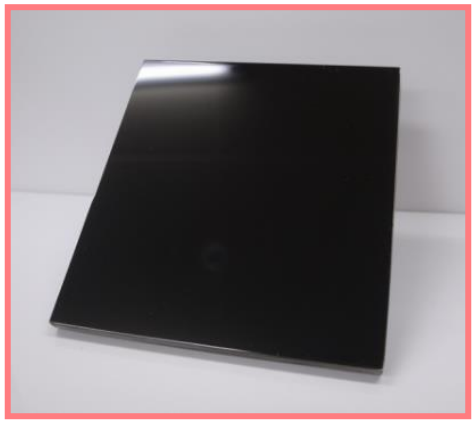
Referred to as “Shimode black”

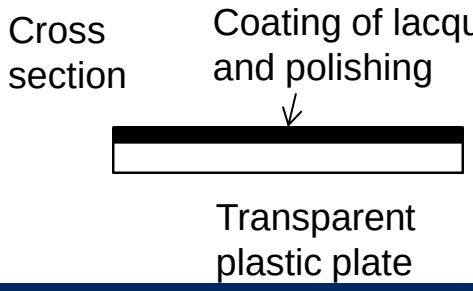
Investigating urushi-arts of Kodai-ji temple

Realization of “Urushi black” with cellulose-based bioplastic

- Target levels were set by analysis of top-level Japanese lacquerware model.
- “Urushi black” has been realized by compounding cellulose resin and special coloring additives.

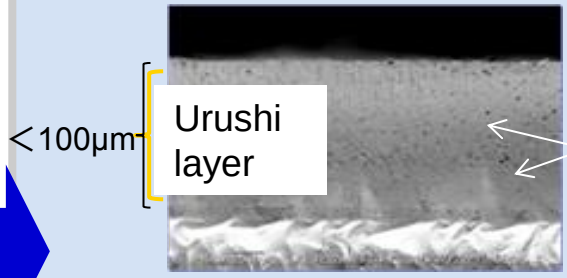
Fabrication of top-level lacquerware model (Dr. Shimode)



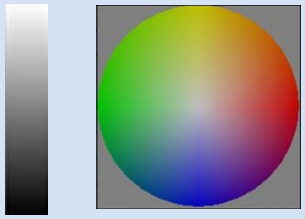


Analysis of lacquerware model

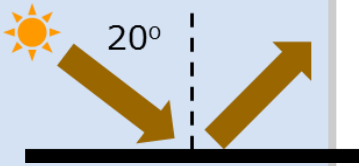
Cross section analysis



Color hue (especially brightness)

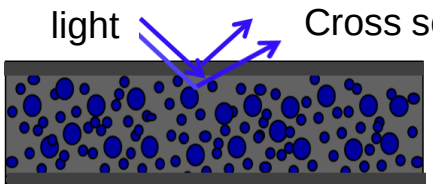


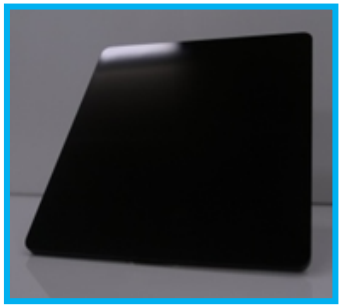
Glossiness



Realization of “Urushi black” by compounding

- High dispersion of black colorants and high-refractive-index additives in resin.
- Molded in ordinary molding process.

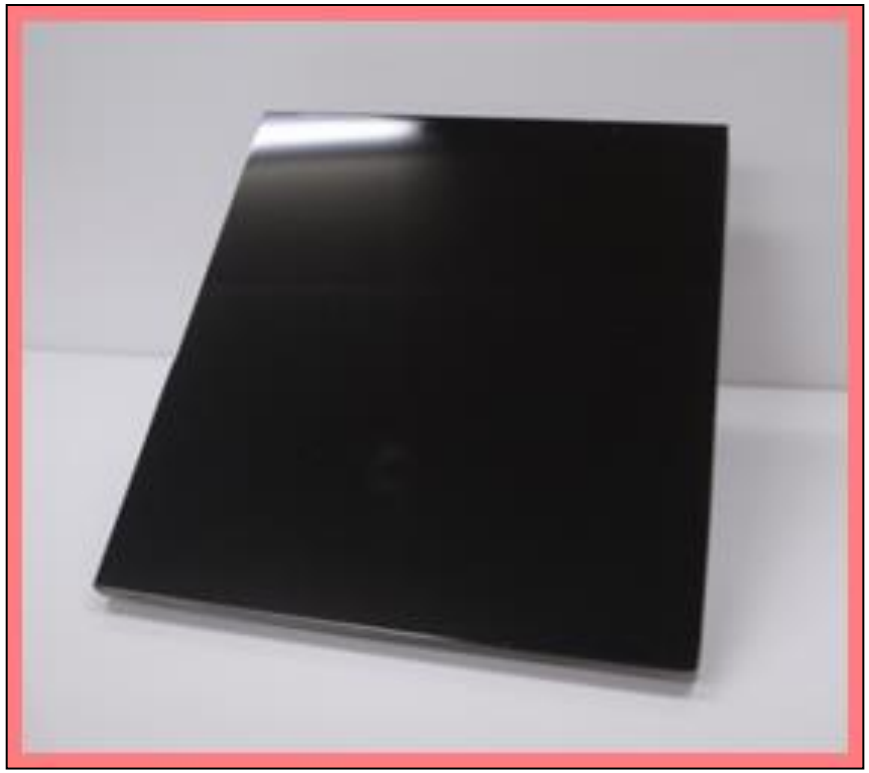


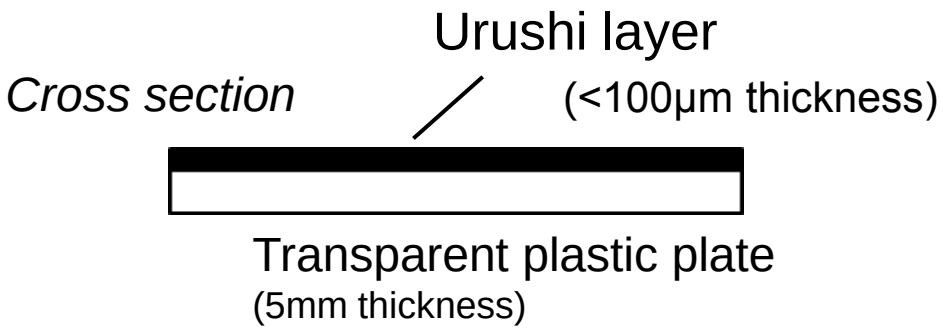


Pursuit of low brightness, high glossiness +α

Fabrication of top-level lacquerware model (Shimode model)

- Top-level Japanese lacquerware model was fabricated by Dr. Y. Shimode.
- Appearance of highest grade lacquerware (ultimate “Urushi black”) was attained by repeated coating of lacquer (urushi) on a transparent plastic plate and polishing of the surface.





Optical characteristics of lacquerware model

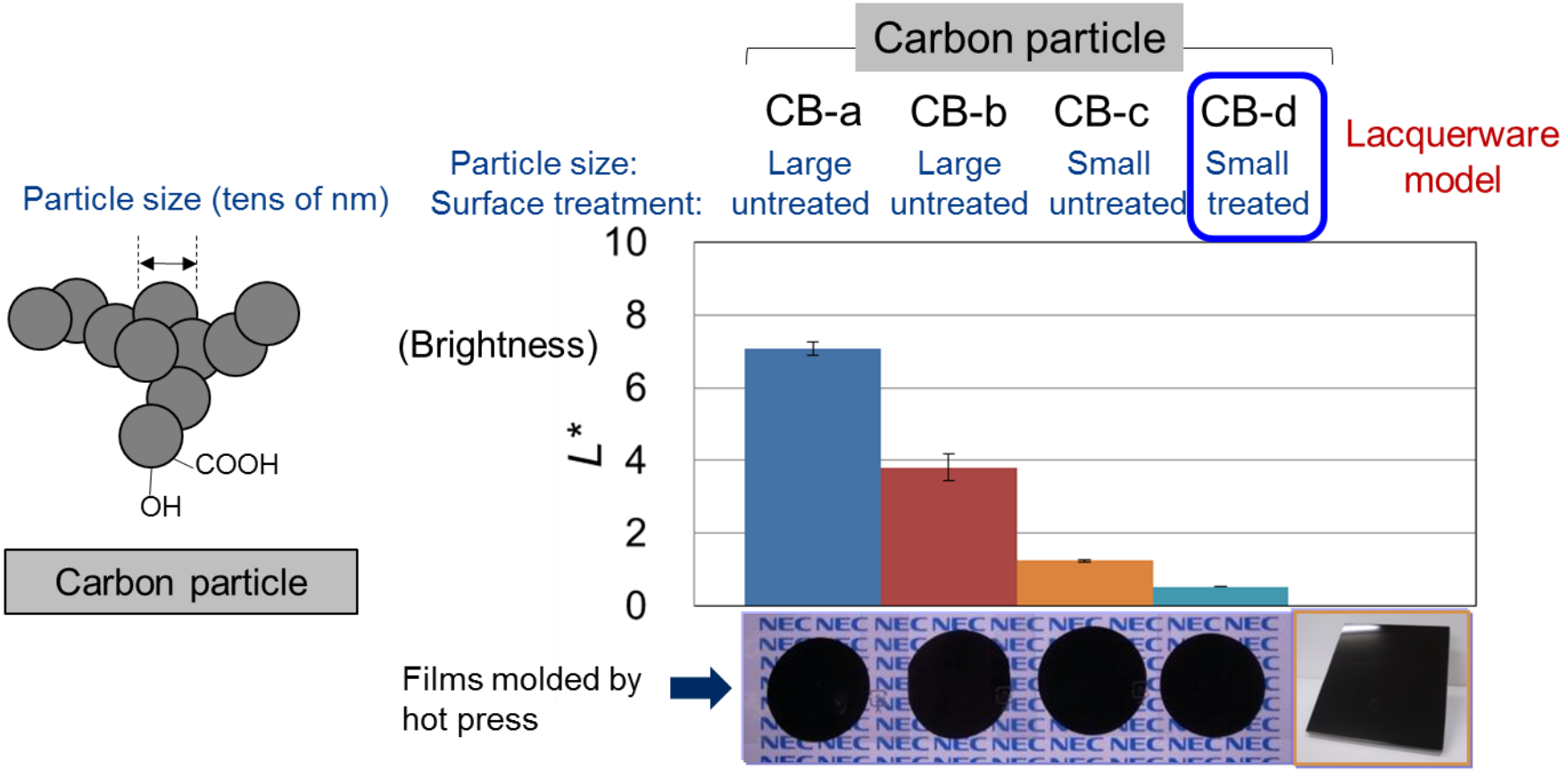
- Extremely low brightness (~1)
- Top-level glossiness (~100)

+α = “depth” and “warmth”

original characteristics of urushi

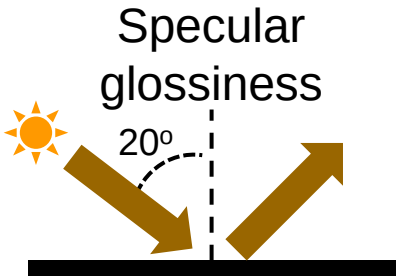
Achievement of low brightness with cellulose bioplastic

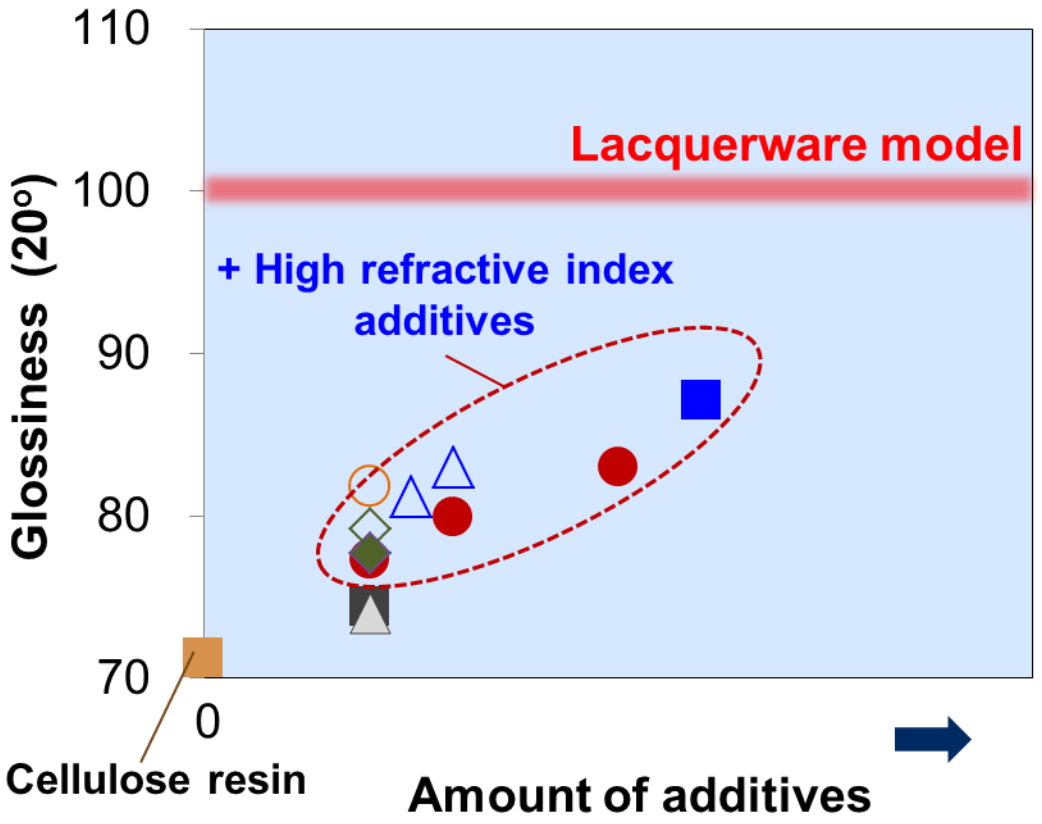
Low brightness has been achieved by addition and mixing (fine dispersion) of surface-treated fine carbon particles.



Realization of high glossiness with cellulose bioplastic

Glossiness has been improved by addition and mixing (fine dispersion) of specific organic compounds with high refractive indices.





Cellulose resin

additive A

A

+ Normal refractive index additive (plasticizing component)

B

C

B&C

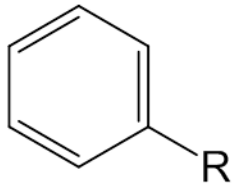
D

E

F

+ High refractive index additives

Example: aromatics

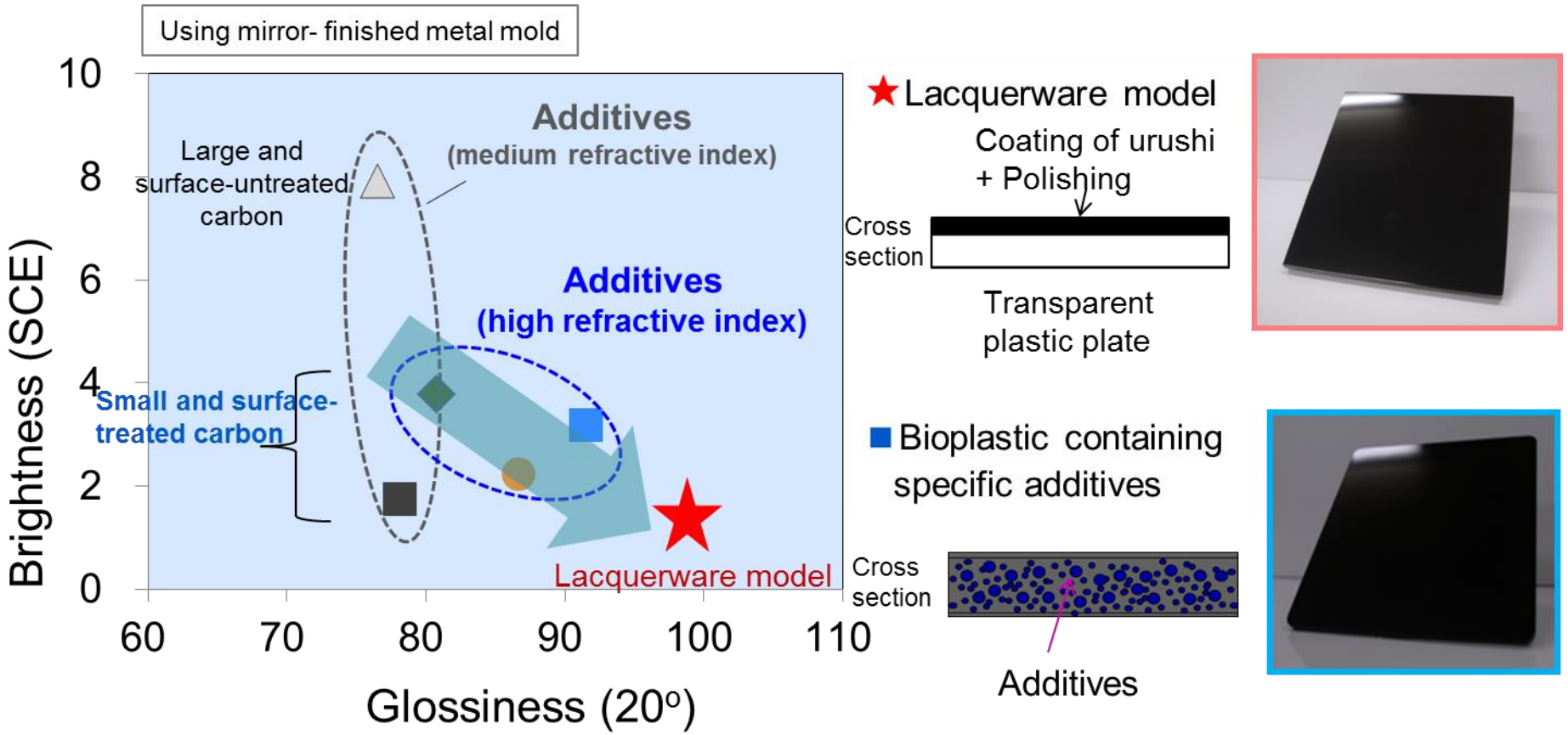


(Evaluation of test pieces)

Simultaneous achievement of low brightness and high glossiness

•There was trade-off between brightness and glossiness, which has been resolved by compounding technology using particular additives.

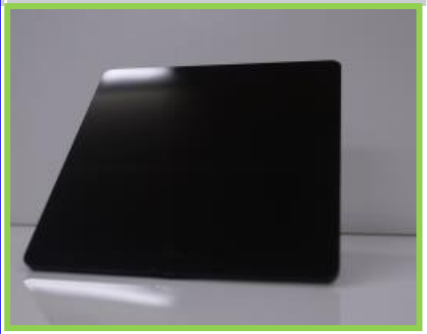
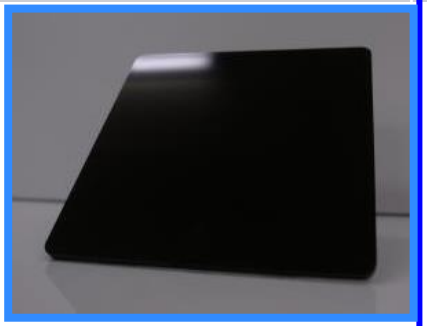
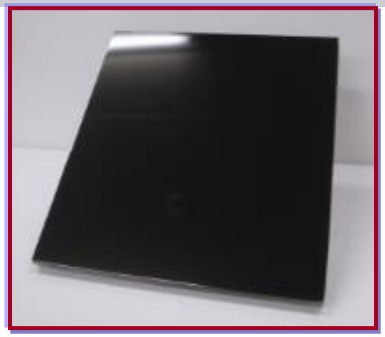
Optimization of surface structures of carbon particles as well as molecular structures of high refractive index organic compounds, and fine dispersion of these additives.



Appearance and optical characteristics

•Low brightness, high glossiness and +α (depth, warmth) characteristic of Urushi have been achieved.

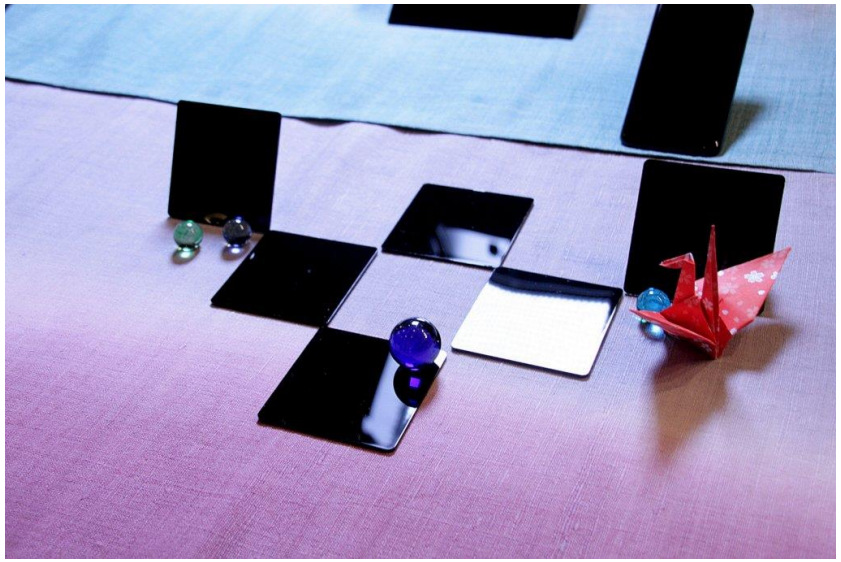
(The depth and warmth are supposed to be influenced by the chemical structure of cellulose resin.)

	Cellulosic bioplastic plates		Lacquerware model
Colorant	Carbon particle (small, surface-treated)	Carbon particle (small, surface-treated)	Dye (Urushiol-Fe)
Additive	Medium refractive index organics	High refractive index organics	-
Brightness *L**(SCE)	**2**	**3**	**1**
Glossiness (20°)	78	**92**	**100**
Glossiness (60°)	85	**95**	100
Appearance			

Using mirror finish mold + adjusting molding condition

”Urushi black” bioplastic

(Molded resin plates)



Other characteristics of ”Urushi black” bioplastic

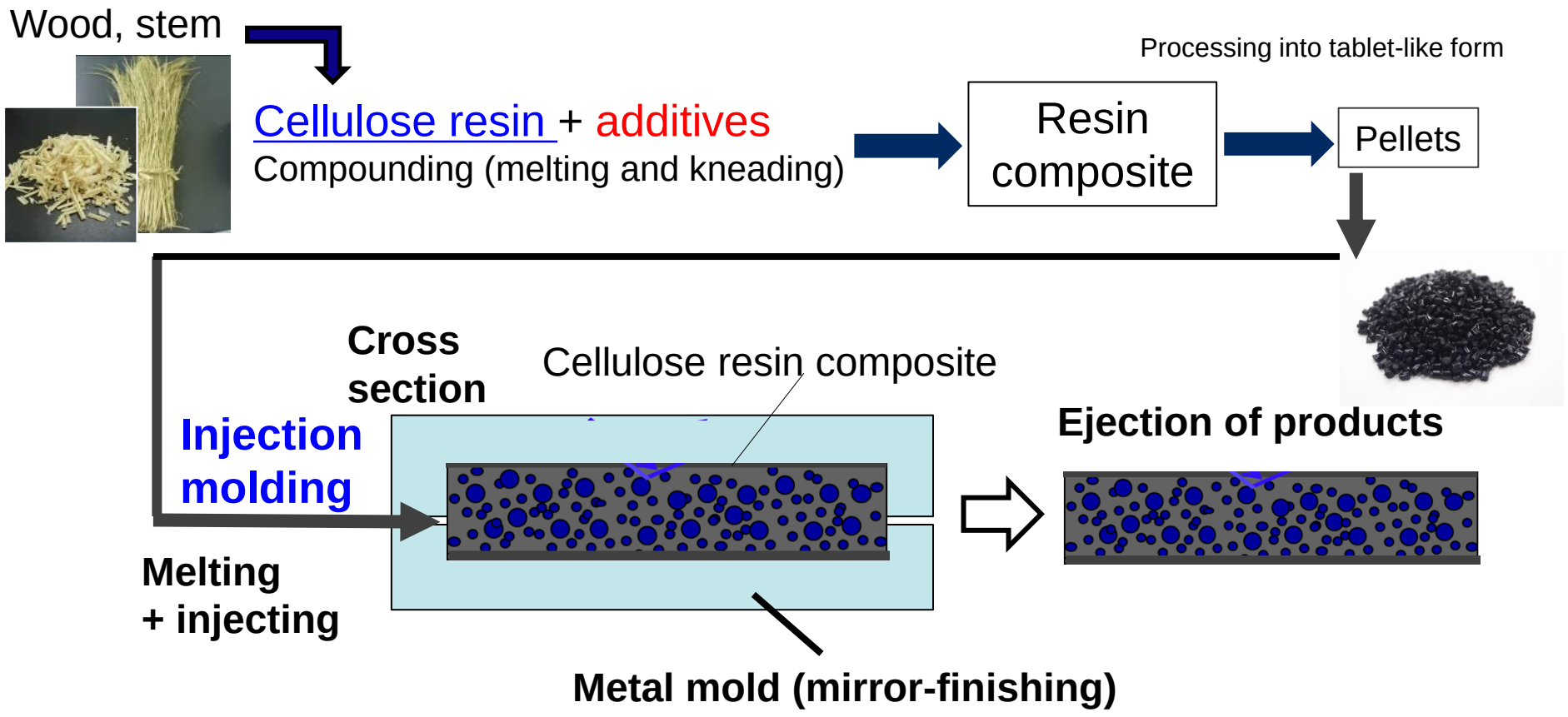
Practical characteristics including mechanical strength, thermoplasticity, and surface hardness were brought to good levels, and these will be further improved.

(The values in the table are representative ones, which will be adjusted depending on application areas.)

	“Urushi black” bioplastic	Petroleum-based resin（ABS）
Flexural strength (MPa)	(~80)	78
Elastic modulus (GPa)	(~2.2)	2.7
Breaking strain (%)	(>10)	>10
Izod impact strength (kJ/m^2)	(~6)	22
Surface hardness (Pencil hardness)	(~HB)	2B
Glass transition temperature (°C)	(>90)	102
Thermoplasticity: MFR (g/10min) 200℃, 50kgf/cm^2	(~400)	280

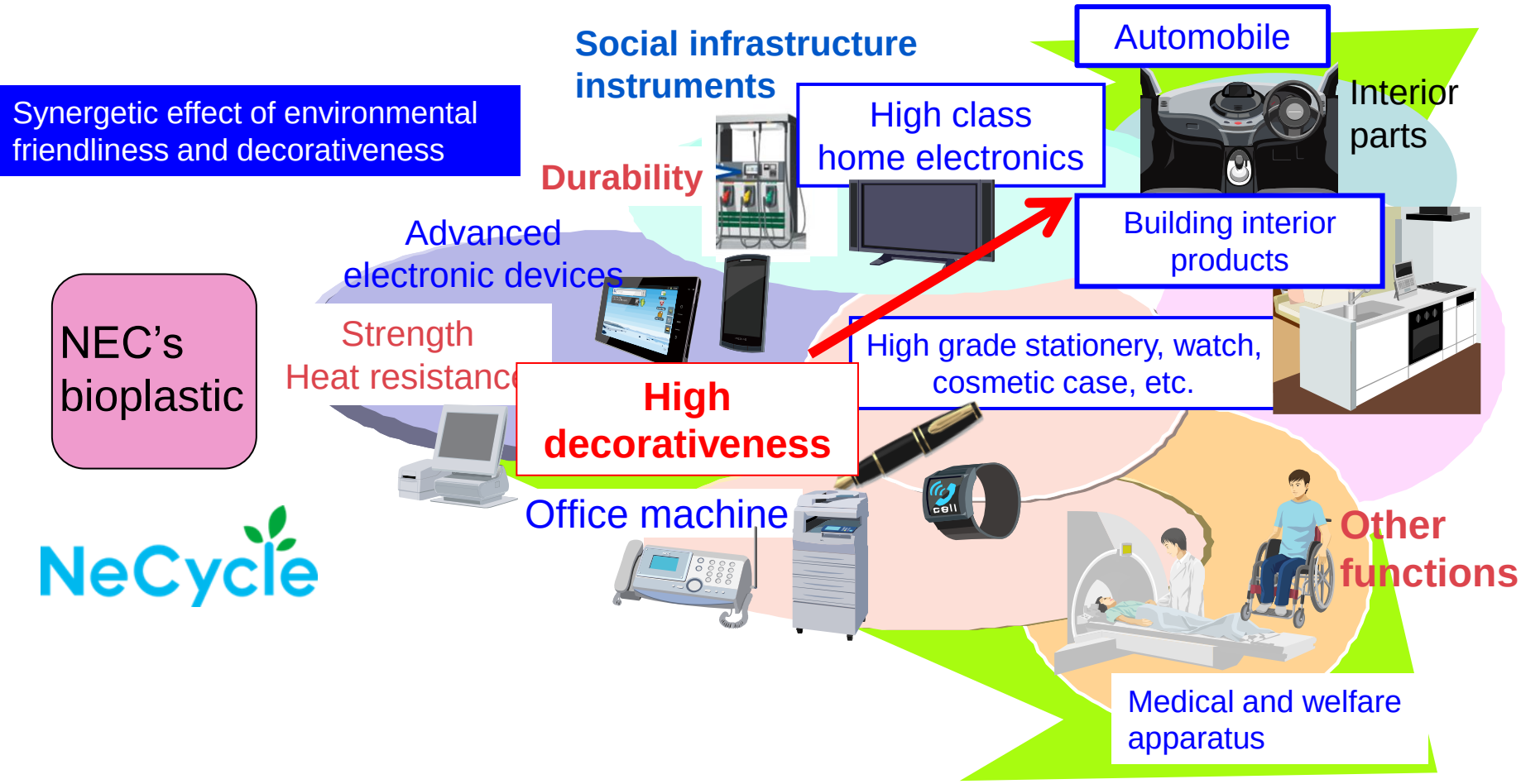
Manufacture and molding of “Urushi black” bioplastic

- The bioplastic is manufactured by mixing specific additives and cellulose resin*.
  *short-chain organic acid bonded cellulose using non-food plant resource
- The composite can be formed into products using ordinary injection-molding process for plastics. → Lacquerware-like products of various shapes can be mass-produced.



Targeted application areas

- Achieving high decorativeness of Japanese lacquerware, we aim to apply the new bioplastic to higher-value-added products.
- NEC will create business partnerships with material producers and product producers to realize the use of the material in various products by 2020.



Summary

- A new bioplastic has been developed which realizes the elegant black color (“Urushi black”) of high-grade Japanese lacquerware.
  - The bioplastic simultaneously has achieved environmental friendliness (use of non-edible-plant resource) and “Urushi black” for the first time.
  - The material can be mass-produced into lacquerware-like products of various shapes using ordinary injection-molding process.
  - Practicality such as strength and formability, and optical properties will be further enhanced.

- Toward 2020, NEC will pursue business partnerships aimed at application of the bioplastic in various products.