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FLUIDGLASS – Facade Elements for Active Solar Control for High-Rise Buildings

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Näher dran
am System
der Technik
der Zukunft

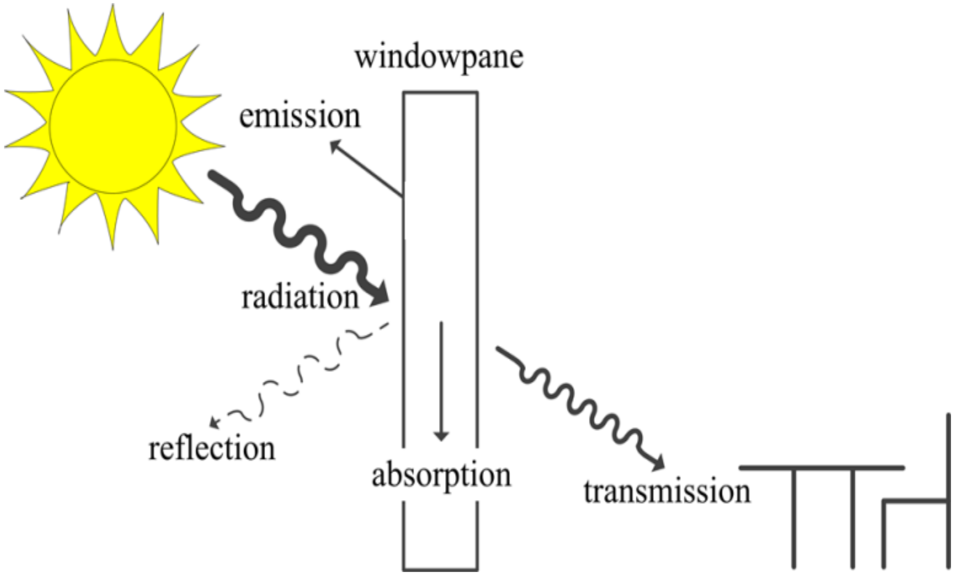
Objectives

- Control of the energy flux through the façade of high-rise buildings
- Increase the comfort of people inside
- Control the solar radiation
- Use the façade as thermal collector
- Support heating, domestic hot water and cooling
- Shading device with variable transmission

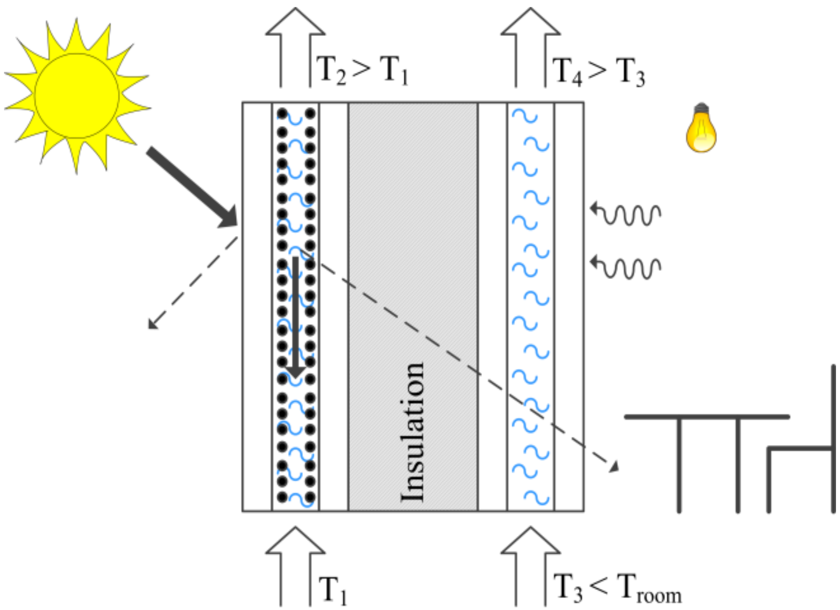
Transparent Facades

Today`s problems

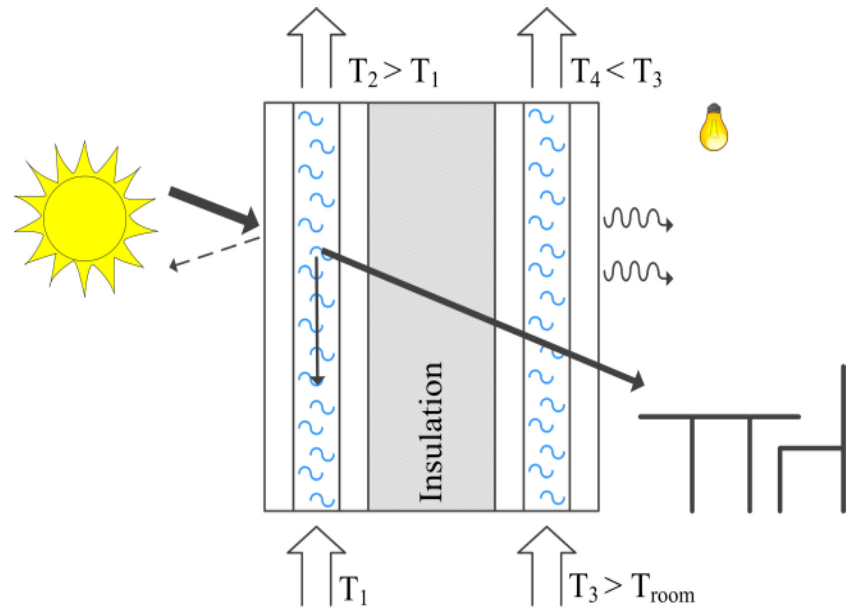
- Energy use
  - summer time leads to overheating and high cooling demand
  - winter time, high heat losses lead to high heating demand
- Comfort – high temperature differences between façade temperature and room temperature
- Venetian blinds
  - Not allowed for more than six floors due to wind forces



Principle of Fluidglass

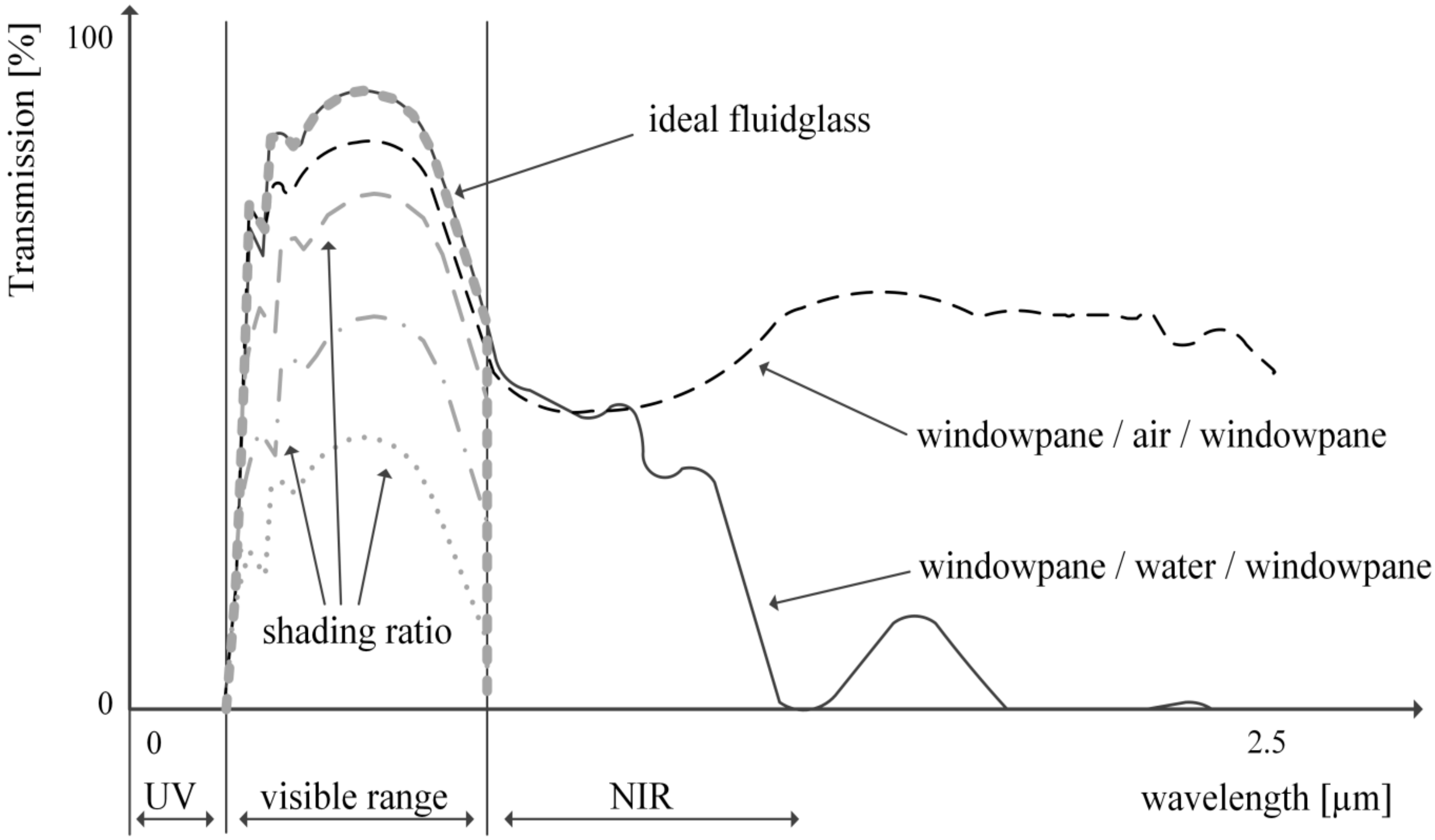


Summer Scenario



Winter Scenario

Transmission rate of windowpanes



Windowpanes filled with air, filled with water and for the ideal fluidglass with several shading values

Simulation model

- Absorbed solar radiation

  For each surface between two zones in forward and backward

  $$\ddot{q}_{A2} = a_2 * \left(\ddot{q}_{R(1-2,out,F)} + \ddot{q}_{R(2-3,out,B)}\right)$$

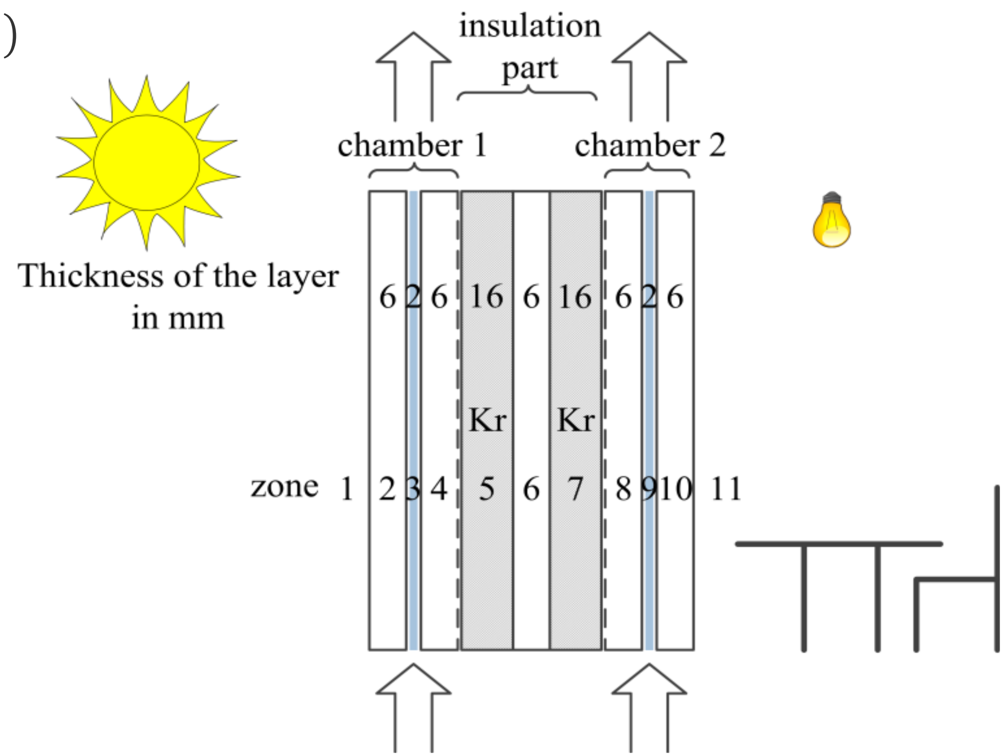
- Reflection

  $$r = \frac{r_{||} + r_{\perp}}{2}$$

- Transmission

  $$I(\lambda) = I_o * e^{-\gamma L}$$

  $$T_{ransmittance} = \frac{I}{I_o} = e^{-\gamma L}$$

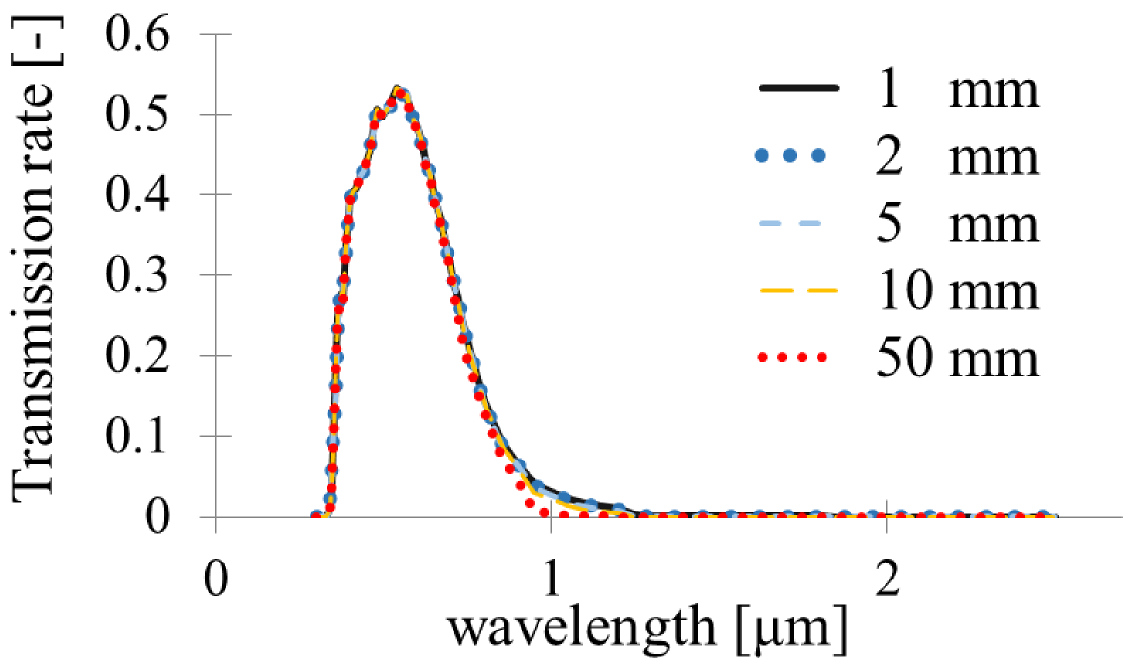


Two simulations

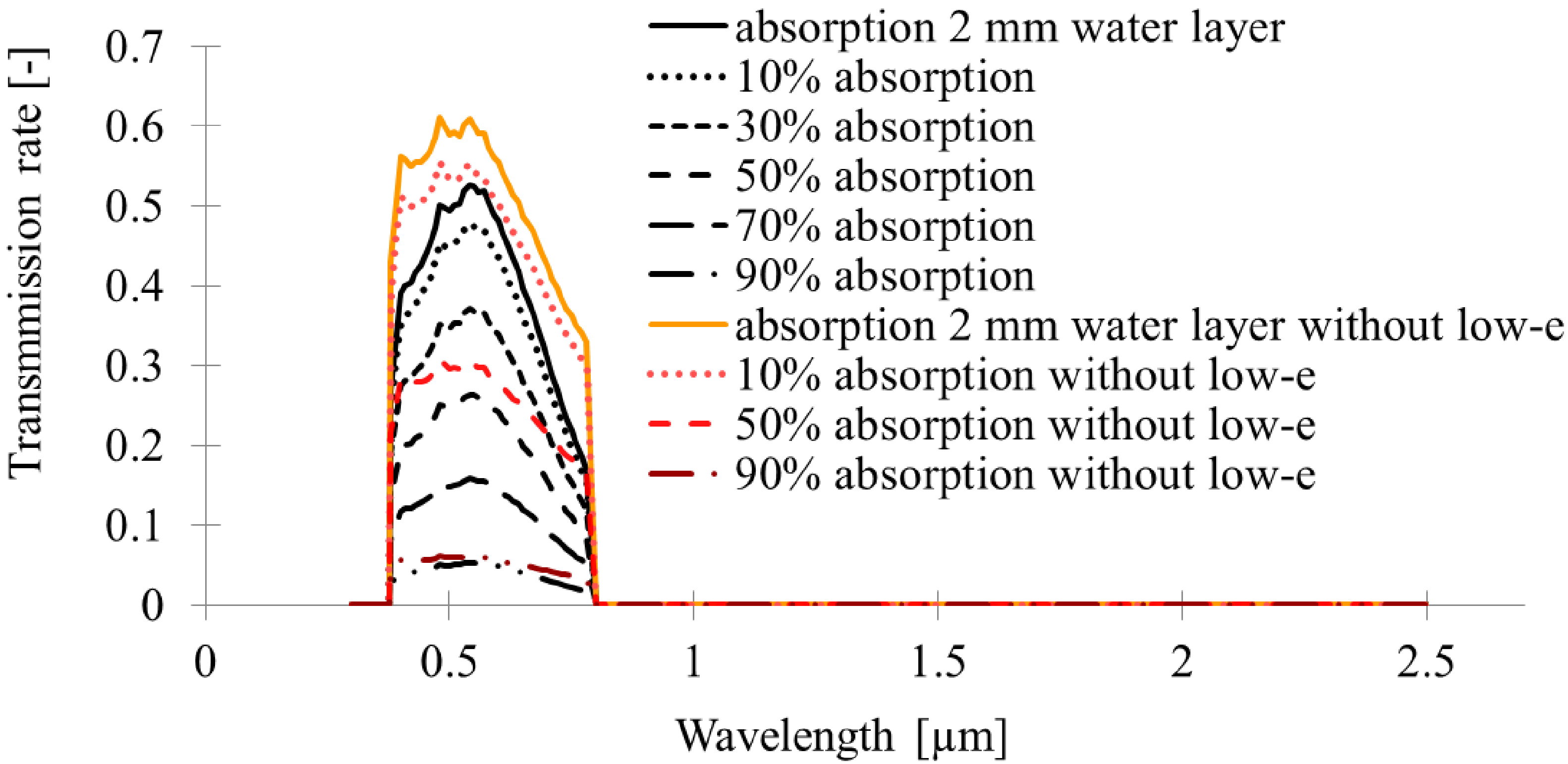
- impact of the outer fluid layer thickness
- Simulation of an ideal fluid – only transmitting visible light (wavelength from 0.38 µm until 0.78 µm) incl. particles

Impact of the outer fluid layer thickness

x [mm]	T_{Sol} [-]	R_{Sol} [-]	A_{total} [-]	A_{ch1} [-]	A_6 [-]	A_{ch2} [-]
1	0.2536	0.2315	0.515	0.3976	0.0578	0.0595
2	0.2533	0.2198	0.527	0.4118	0.0562	0.0589
5	0.2524	0.2081	0.540	0.4278	0.0537	0.0580
10	0.2512	0.1986	0.550	0.4417	0.0514	0.0571
50	0.2452	0.1775	0.577	0.4797	0.0442	0.0534

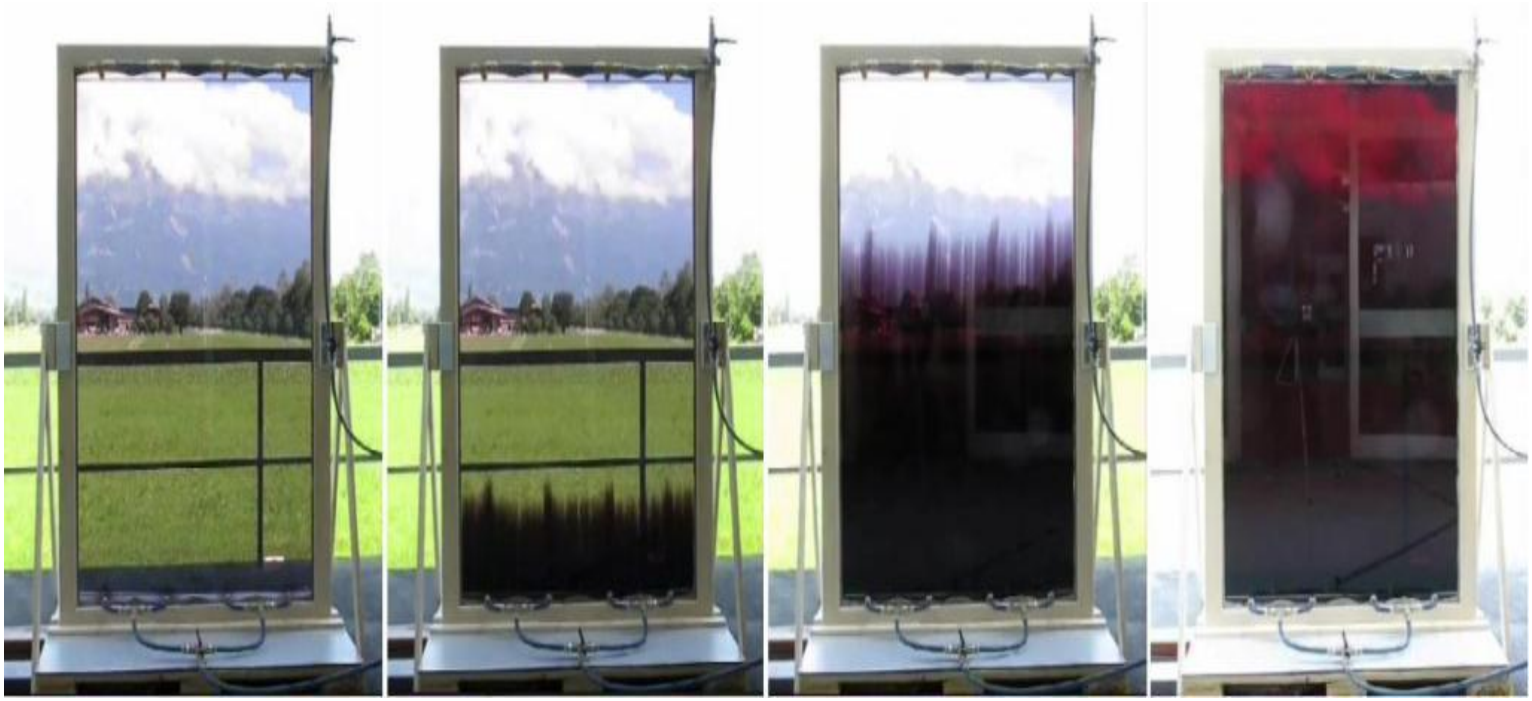


Simulation results - ideal fluid with particles



- Comparison of glass systems with and without low-emissivity coating
- Reduction in transmission with low-e coating
- Particles are added to the fluid to increase the absorption rate

Prototype



- Demonstration of shading process
- Colorant to vary the absorptivity was used
- 2 mm fluid layer thickness
- Pressure inside the façade is under ambient pressure

Conclusions

- The fluid layer thickness has almost no influence on the transmission rate through the window

- Simulation of an ideal fluid which represents the addition of ideal particles shows:
  - At a shading rate of 50% the first fluid layer will absorb 77% of the total heat flux
  - No shading: only 23% of the incident radiation will pass through the façade, reducing the heating load of the building considerably.

- In combination with the ideal fluid the low-e coatings only have a minor effect

Future Work

- Finding the best fluid-particle and glass – low-e coating combination
- Measuring system efficiency
- Improving reliability and durability
- Second Prototype