Reduction of Reflected Heat of the Sun by Retroreflective Materials

Hideki SAKAI, Kazuo EMURA, Norio IGAWA
Dept. of Housing and Environmental Design

Hiroyuki IYOTA
Dept. of Mechanical Engineering

Osaka City University

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We are proposing to use retroreflective materials as an anti-heat island measure.

Outline of my talk

1) **Key idea**: Why retroreflective materials are effective "*especially*" in Osaka?

2) **Demonstration**: the anti-heat island effect of retroreflective materials.

3) **Evaluation**: How to evaluate the retroreflective properties.

Where is Osaka?

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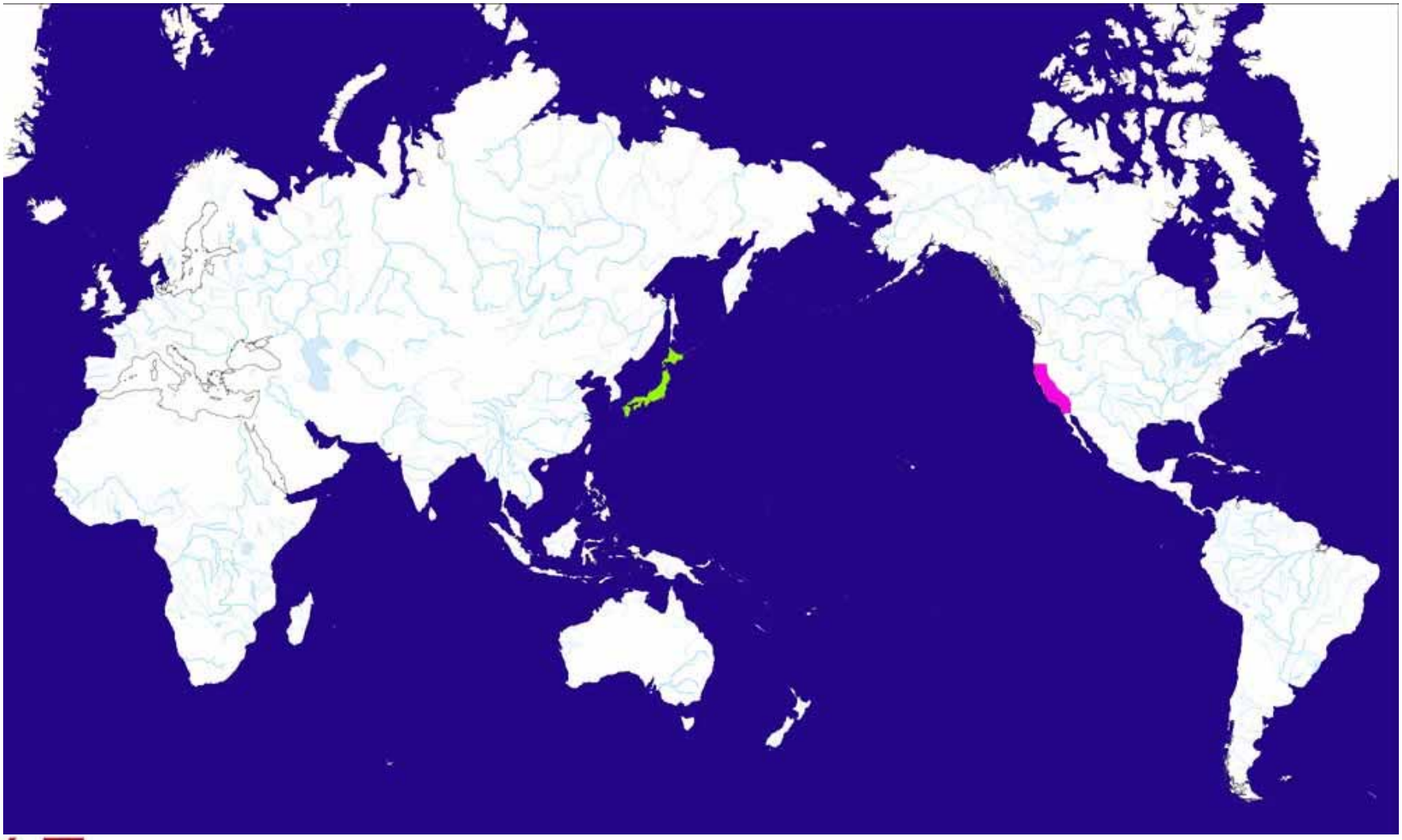
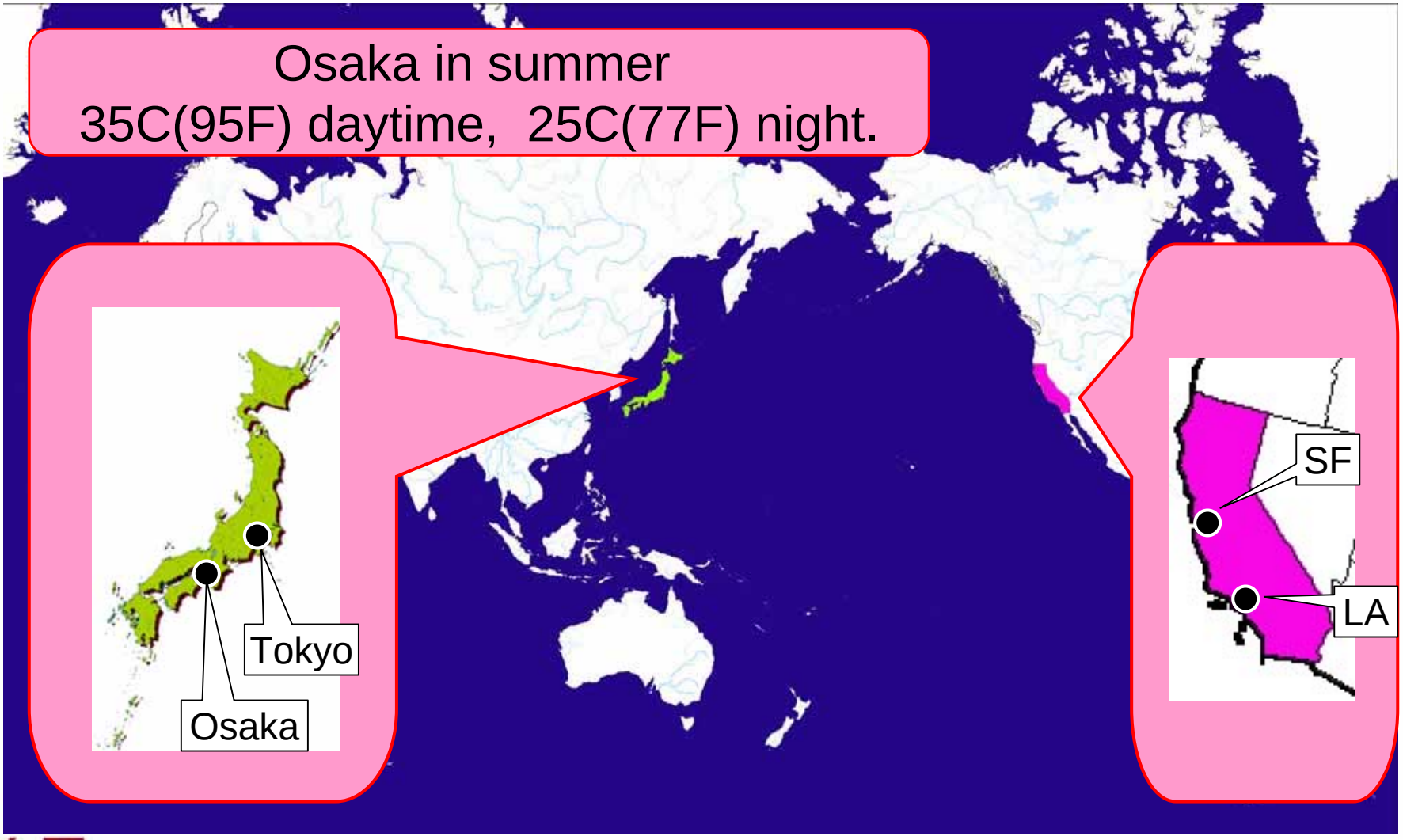


Where is Osaka?

Osaka in summer
35C(95F) daytime, 25C(77F) night.

Where is Osaka?



Ginza, the central part of Tokyo (JAPAN)

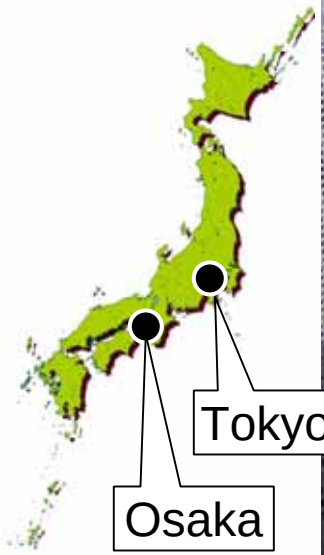
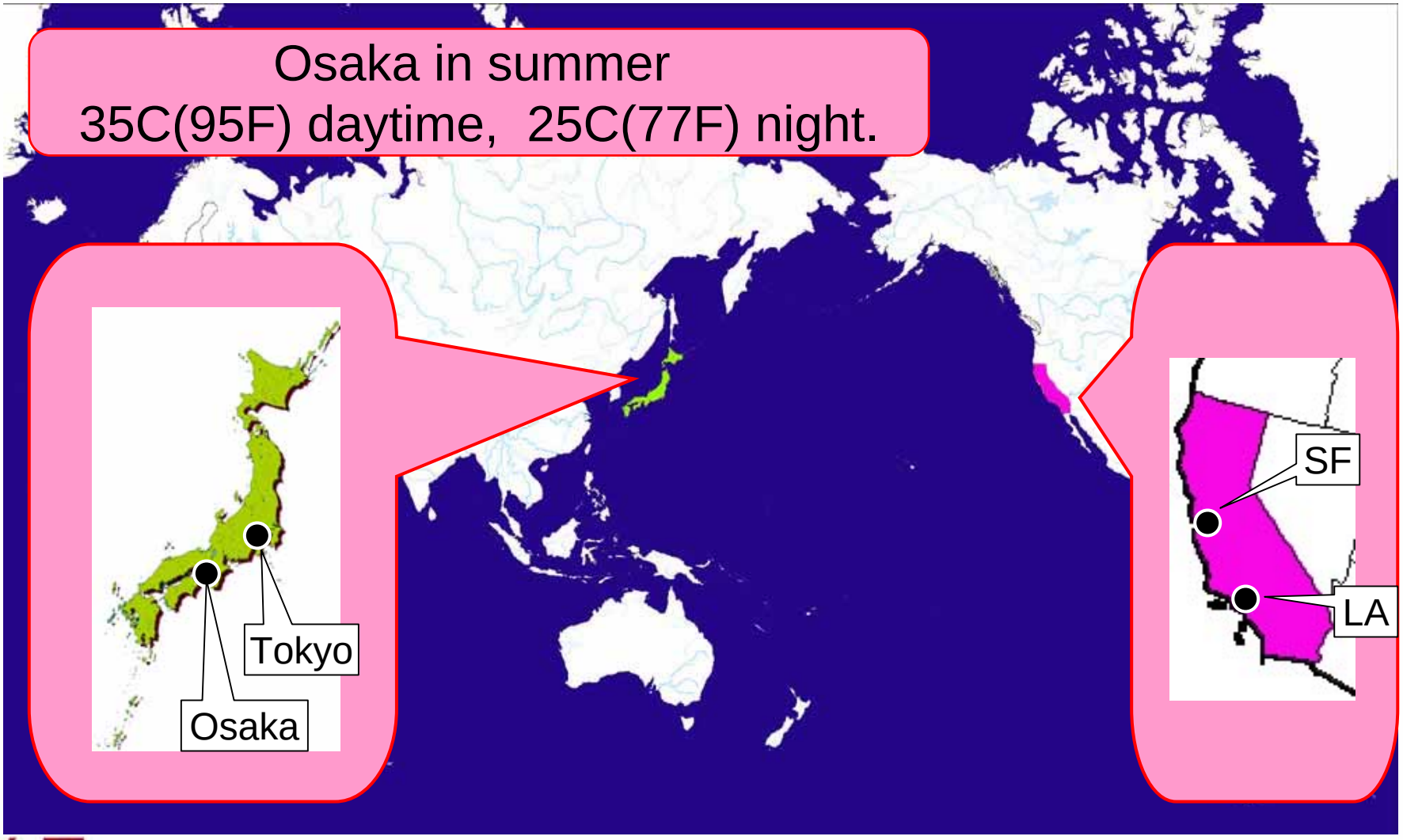


photo: Sakai, 4 Aug 2009

Umeda, the central part of Osaka (JAPAN)

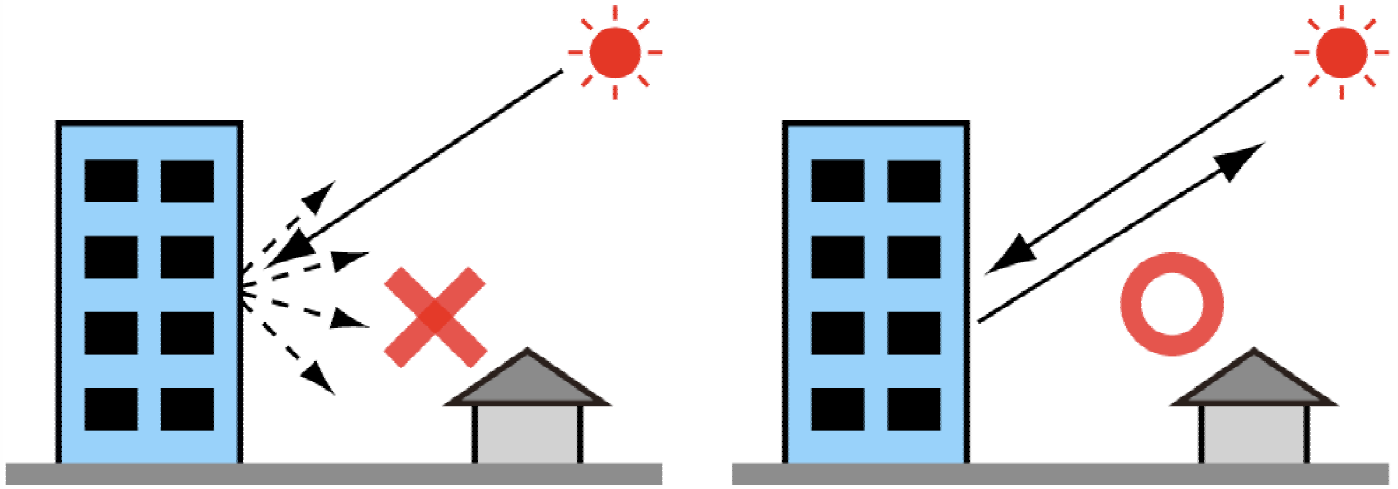
photo: Sakai, 17 Jul 2005

Where is Osaka?



Key idea of our study

High reflective materials are used to reduce the amount of solar heat absorbed by building surfaces.



Diffuse vs. Retro-reflective

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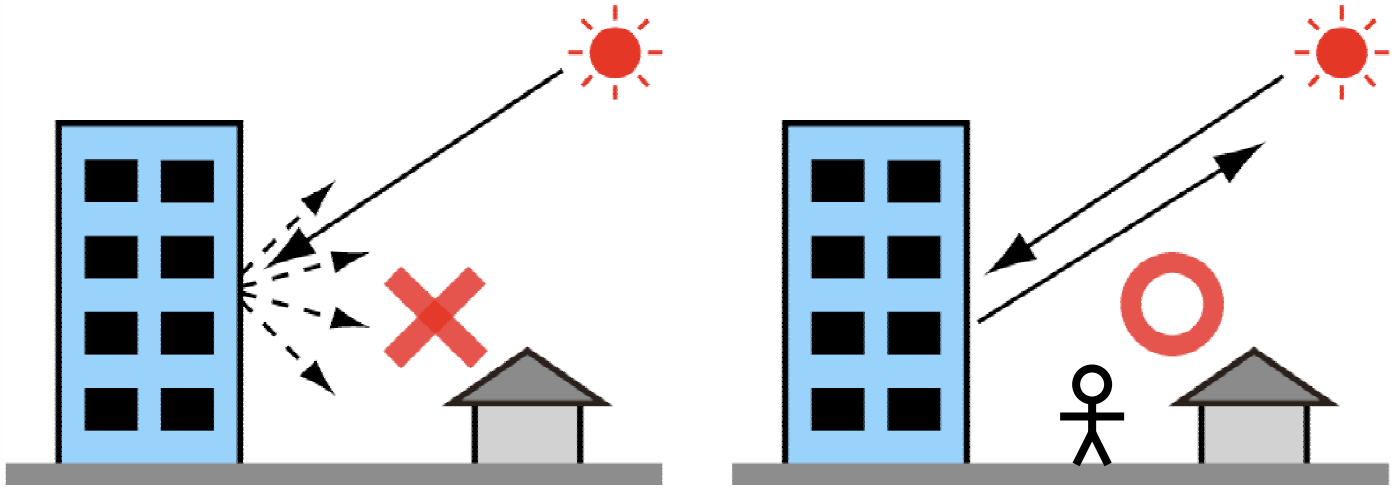
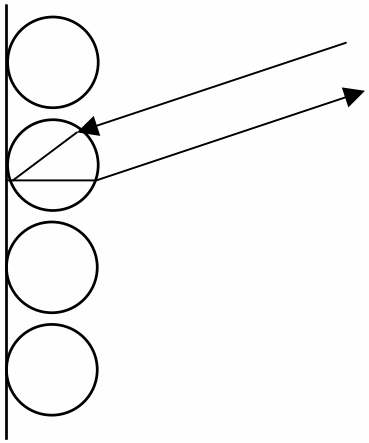
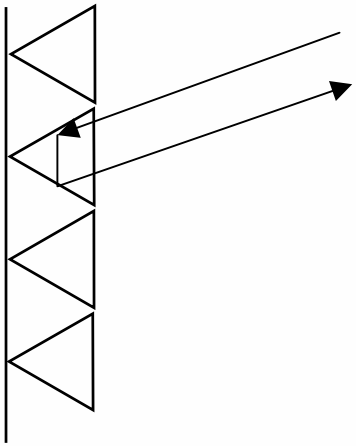


Diffuse vs. Retro-reflective

Retroreflection: returns light back to its source



ball lens optics
(beads)

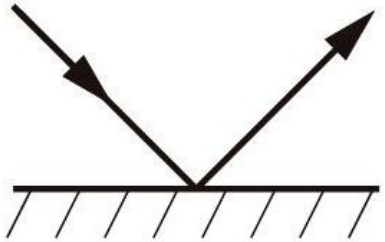


corner cube optics
(prism)

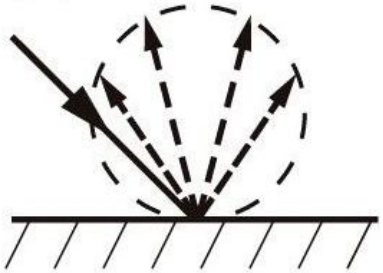
They are used as the road markings and signs to enhance night-time visibility.

Experimental Setup: Miniature model of urban canopy

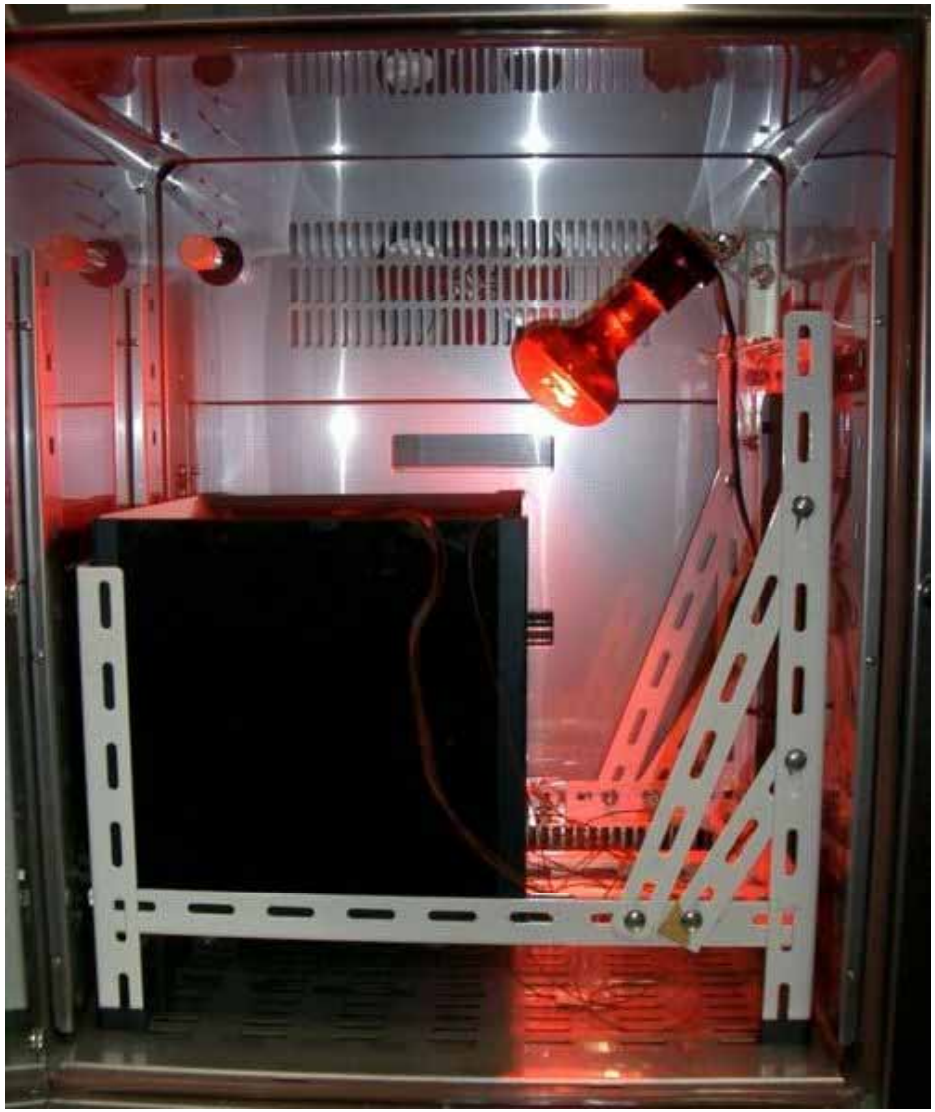
(a) Specular reflection



(b) Diffuse reflection

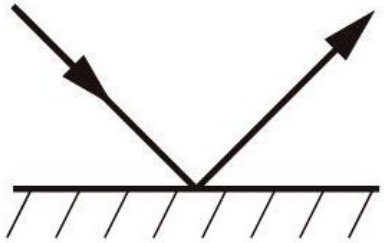


(c) Retroreflection

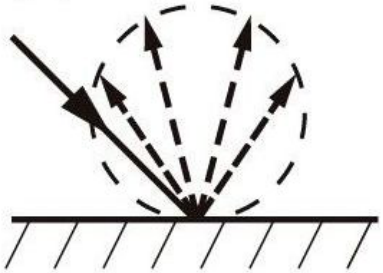


Experimental Setup: Miniature model of urban canopy

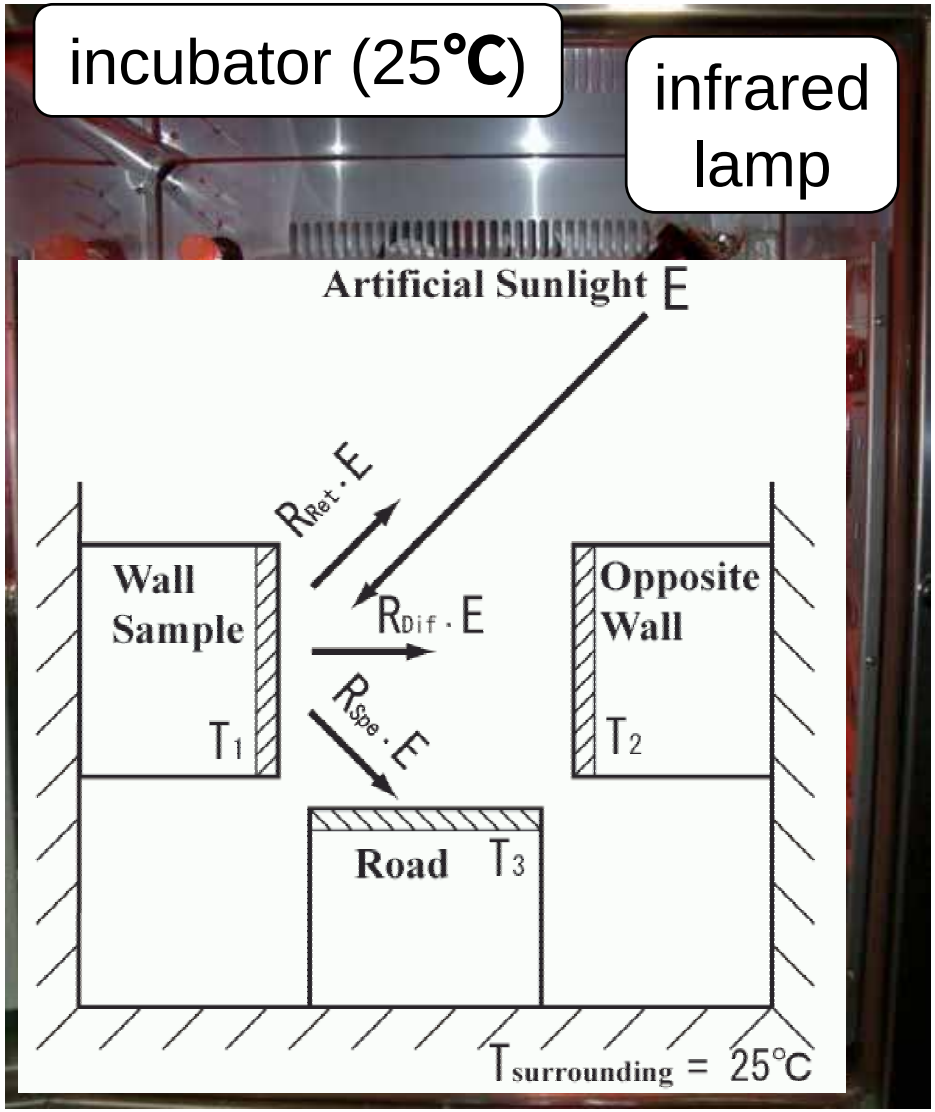
(a) Specular reflection



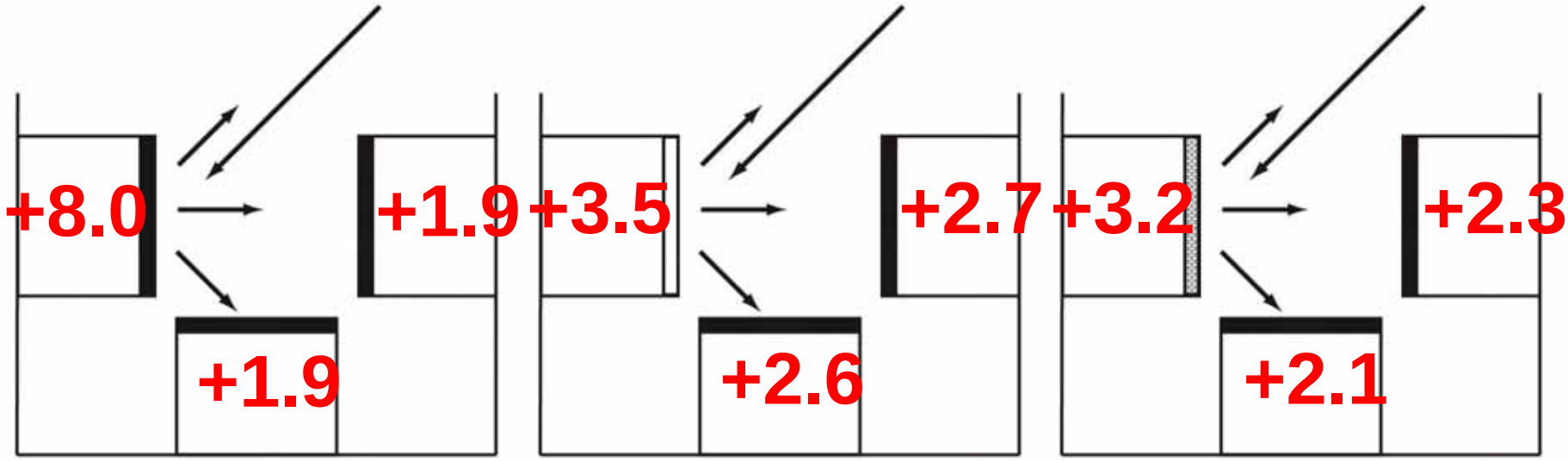
(b) Diffuse reflection



(c) Retroreflection



Experimental Result: Rise in Temp. by Irradiation

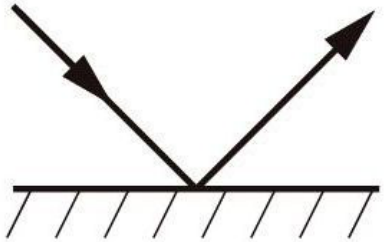


black paint **white paint** **retroreflective sheet**

Retroreflective surfaces can reduce
the absorbed heat and the reflected heat.

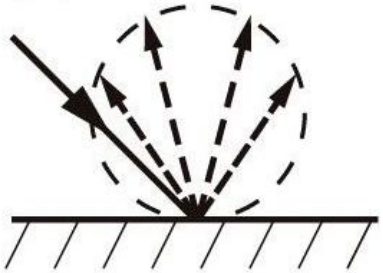
Retroreflectance Measurement

(a) Specular reflection



R_{Spe}

(b) Diffuse reflection



R_{Dif}

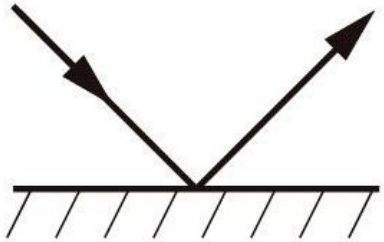
(c) Retroreflection

R_{Ret}

Integrating Sphere Measurement

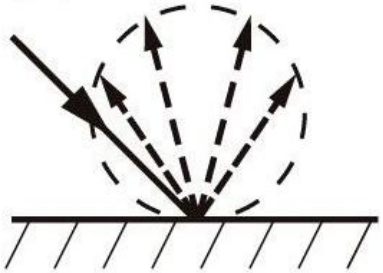
Retroreflectance Measurement

(a) Specular reflection



R_{Spe}

(b) Diffuse reflection



R_{Dif}

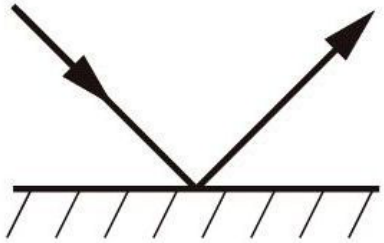
(c) Retroreflection

~~R_{Ret}~~

Integrating Sphere Measurement

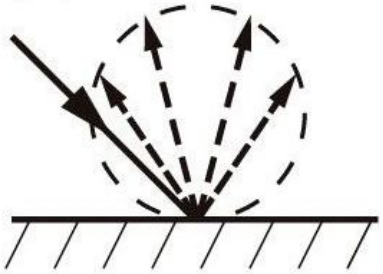
Retroreflectance Measurement

(a) Specular reflection



R_{Spe}

(b) Diffuse reflection



R_{Dif}

(c) Retroreflection

~~R_{Ret}~~

Integrating Sphere Measurement

$$R_{Tot} = R_{Spe} + R_{Dif} + R_{Ret}$$

$$R_{Ret} = R_{Tot} - R_{Spe} - R_{Dif}$$

Future of Retroreflective materials

Score table

	Reduction of Absorbed Heat	Reduction of Reflected Heat	Cost
High-reflective	○	△	○
Retroreflective	○	○	△
Movable mirror	○	○	×

Summary

1) **Key idea**: Why retroreflective materials are effective "*especially*" in Osaka?

2) **Demonstration**: the anti-heat island effect of retroreflective materials.

3) **Evaluation**: How to evaluate the retroreflective properties.