Recent Applied Research of Synchrotron Radiation in Kobe Steel.

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The purpose of a recent applied research of SR in Kobe Steel Ltd. is feedback of data to the functional materials development research (electronic material, metal, alloy, and catalyst, etc.). In addition, the new X-ray analysis method development research is important needs. In this lecture, four examples (atmosphere corrosion resisting steel, two alloys, and new X-ray analysis development research) are introduced from among the research of the above-mentioned.

Figure 1 is one example of the result achieved by the new X-ray analysis development. The X-ray reflectivity curve of the copper film spattered on the silicon wafer was measured by the use of the wave length of the copper absorption edge, and the diffuse scattering of X-rays was measured by seven parts of the total reflection critical angle neighborhood. The θ-2θ position was fixed by seven places on the obtained profile in the ruggedness part, and the reflection mode XAFS was measured. The spectrum that the ratio of metal copper and the oxides is different according to each measurement position was obtained. This result is suggested that the spectrum contain more detailed surface information like spots on the surface etc. compared with the usual reflection mode XAFS. We want to name this method DSXAFS (Diffuse scattering XAFS).

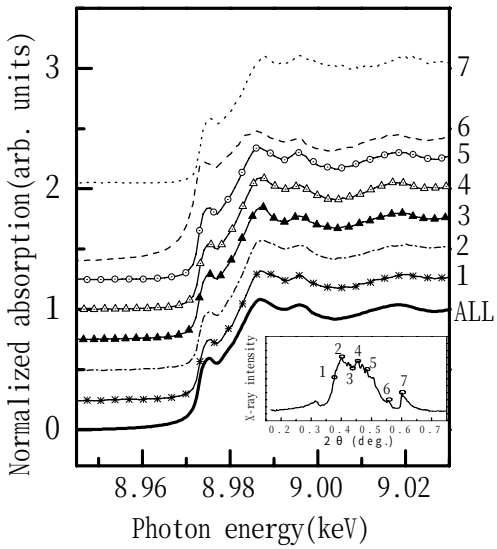

Figure 1 DSXAFS of Cu *K*-edge.

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KOBE STEEL, Ltd.

(KOBELCO RESEARCH Inst., Inc.)

Takashi Watanabe

Feedback of SR Applied Research

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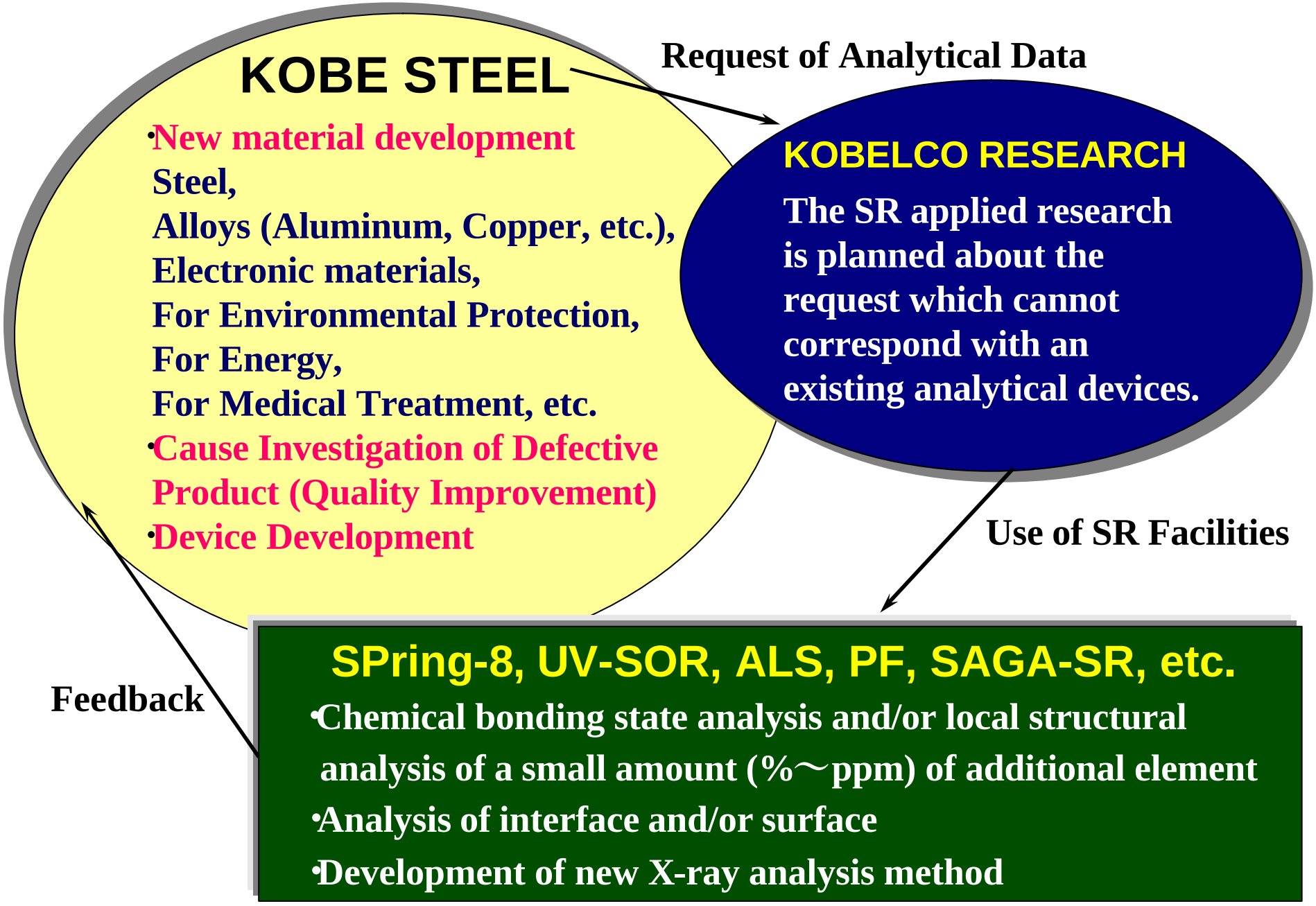

Appl. Example 1: Structural Analysis in extraction form of Cu in micro-alloy by SR-XAFS.

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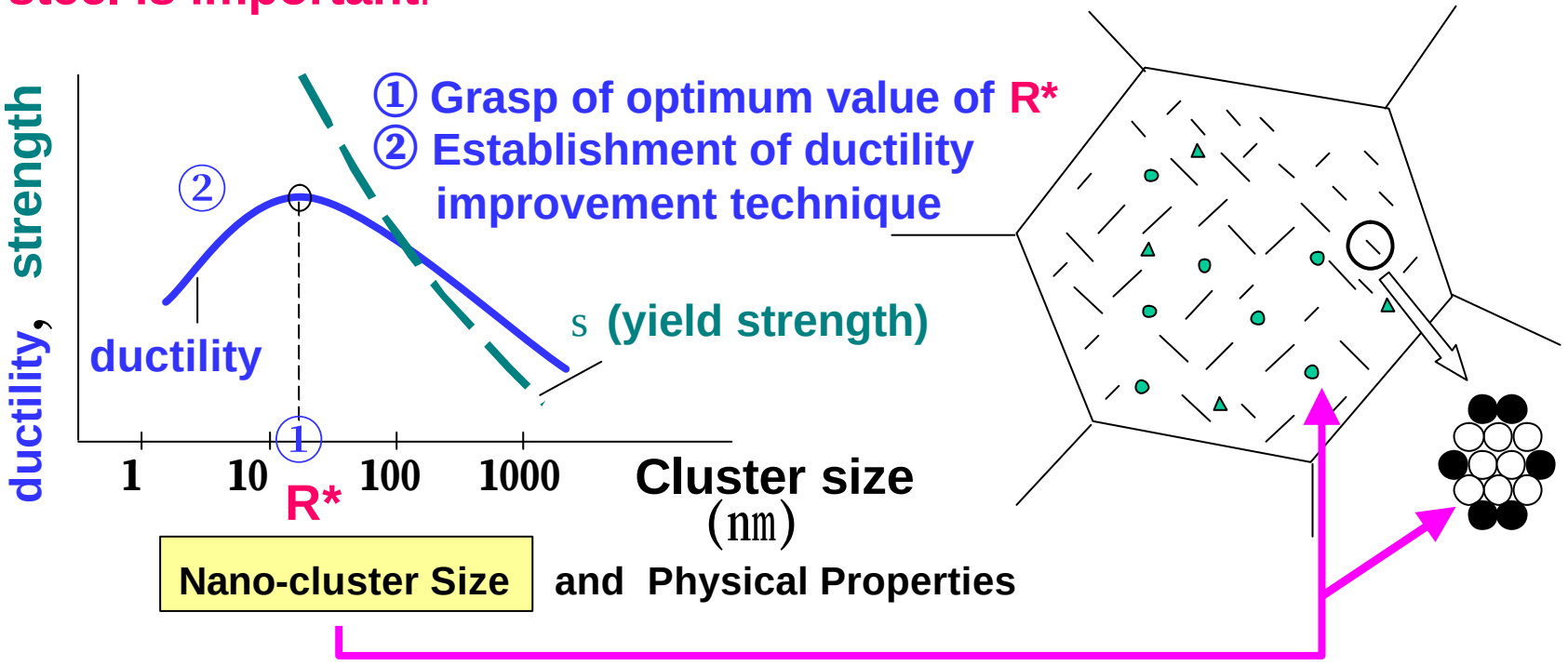
For the reduction in Greenhouse Effect Gases

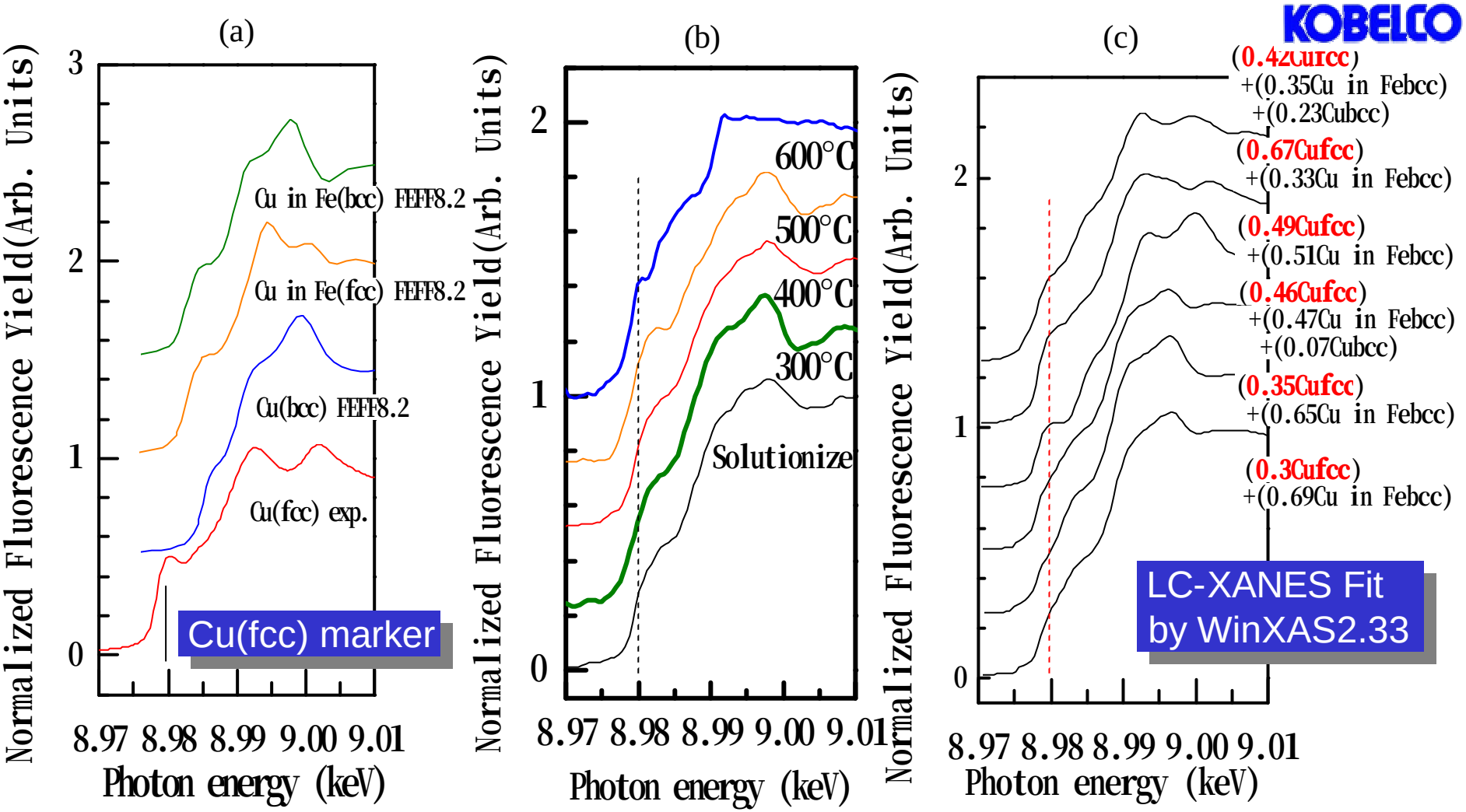
～Lighten the automobile～

- Make steel a high strength,
- Achieve the high strength and making to a high function, and hyperfine structure with the alloy which saves the additional element.

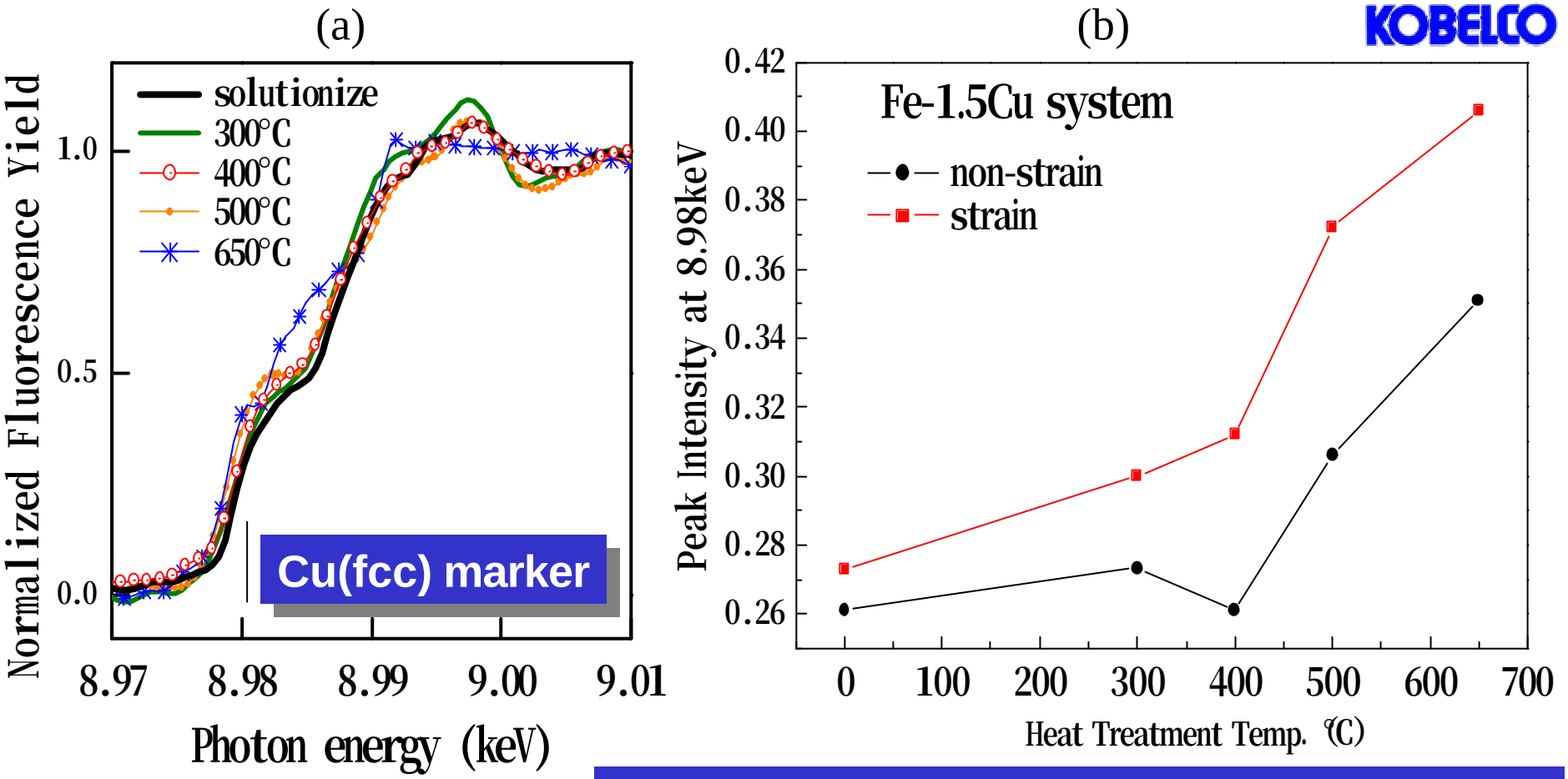
→The elucidation of the deposition behavior of Cu in micro-alloyed steel is important.



Decision of the optimum cluster size/shape/distribution/characteristic



Copper *K-edge* XANES ; (a)standards,
(b) the ultra fine grained Cu-bearing steels (Fe-1.5Cu)
which added the strain , and (c) LC-XANES fit results.



As the heat-treating temperature rise ・・

Cu in Fe(bcc) → **Cu(fcc)**

solid solution　　nano-cluster

Copper *K-edge* XANES of the ultra fine grained Cu-bearing steels (Fe-1.5Cu) which added the strain (a) and the peak intensity at 8.98keV (b).

Appl. Example 2: *In situ* X-Ray Radiography for Porous Aluminum

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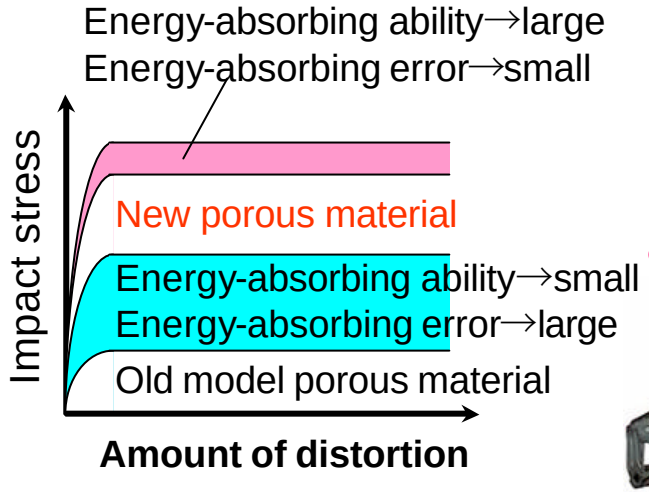
～For the earth environment and a safe, pleasant car life～

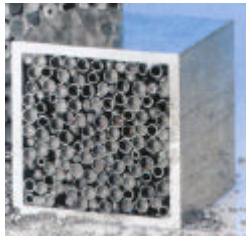
Design needs (lightening, safety, and recycling)

↓

Control of density, strength, and collision energy absorption property by making of metal porous



Applied frontside frame of porous metal (cell structure body), bumper, door, floor, and absorber, etc.

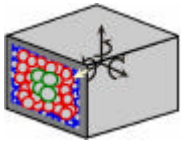


We aims at achievement of lightening and the collision safety improvement simultaneously.

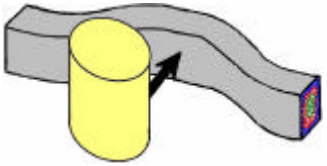
Homogenizing of form distribution

Make the form shape spheroidal

Make the form size minute



Rigidity



Bend

Impact

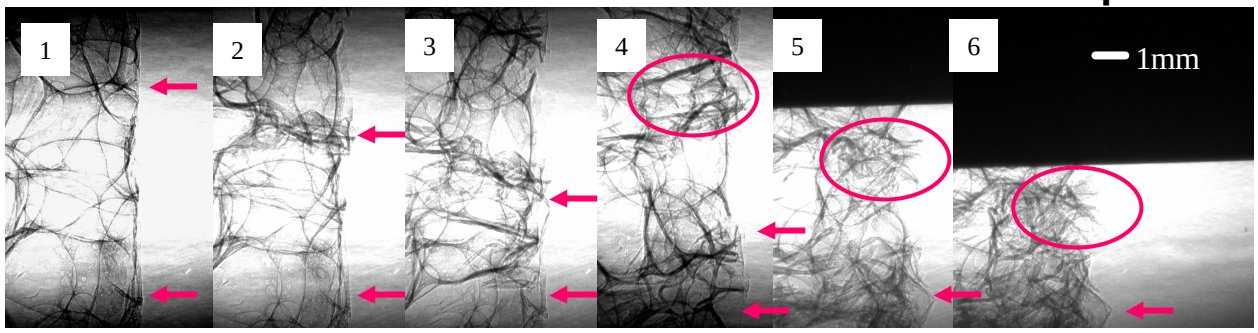
Grasp of bombarding energy absorption property

Data base maintenance

Comparison between 6 scenes of the *in-situ* image monitored by X-ray radiography

← Buckling destruction

○ Explosion



<BL19B2>

33keV, Si(311)

<CCD Camera>

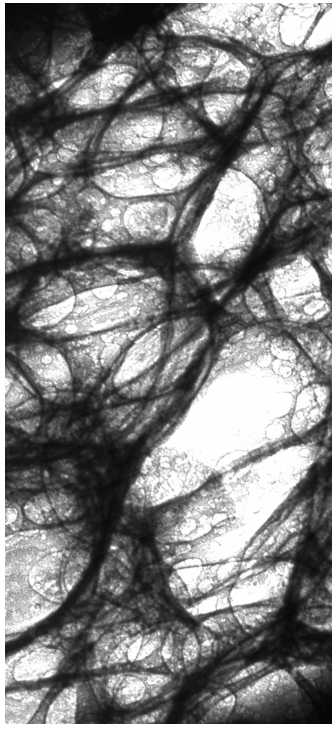
1000 x 1000pixel - 30Hz

C8800

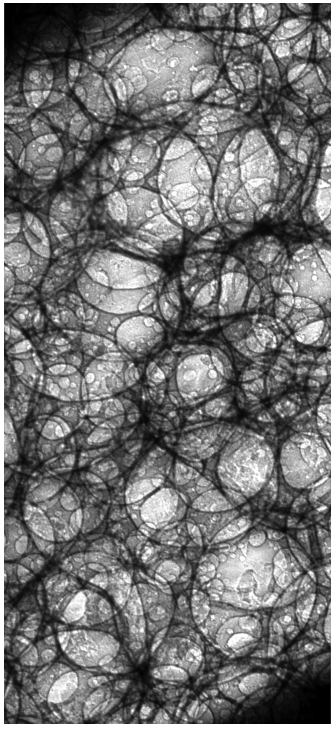
8.0 μm pixel size, 80msec

(Hamamatsu photonics K.K.)

Static image of two types of foam aluminum by X-ray radiography



10 mm



10 mm

<BL16B2>

18 keV, Si(111) double crystal

<CCD camera>

2048×2048 pixel–12bits

MegaPlus ES4.0/E

8.0 μm pixel size, 90msec

(Nippon Roper K.K).

Each image is constracted by 11images.

The panorama method was adopted.

In-situ Dynamic image of two types of foam aluminum monitored by X-ray radiography

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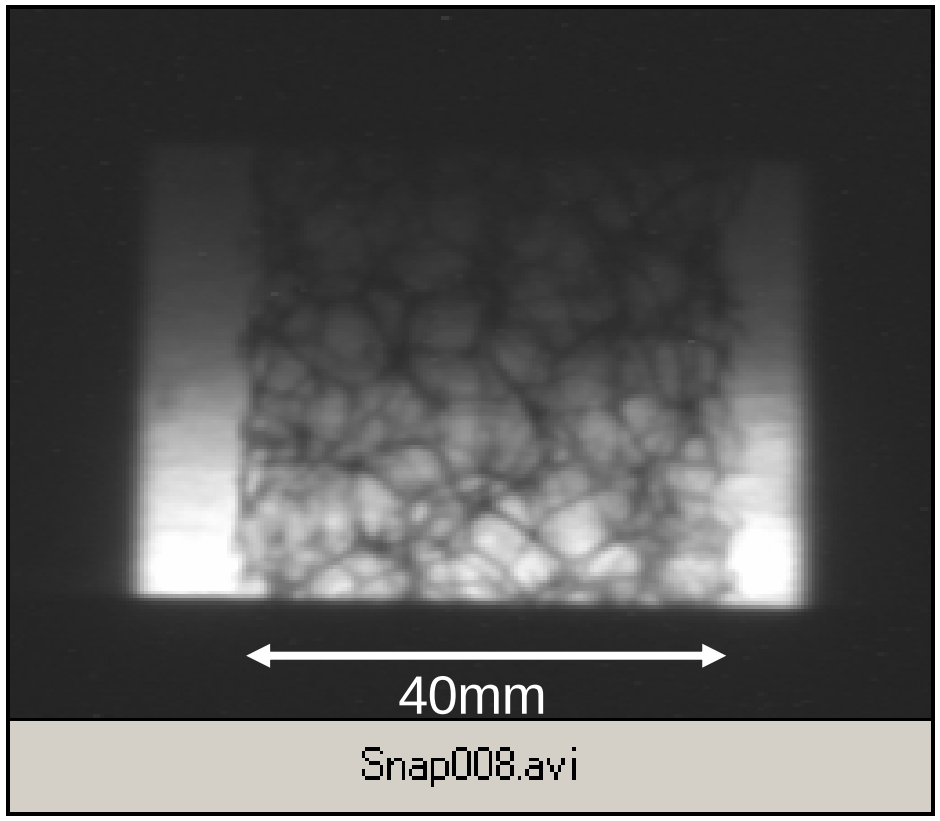

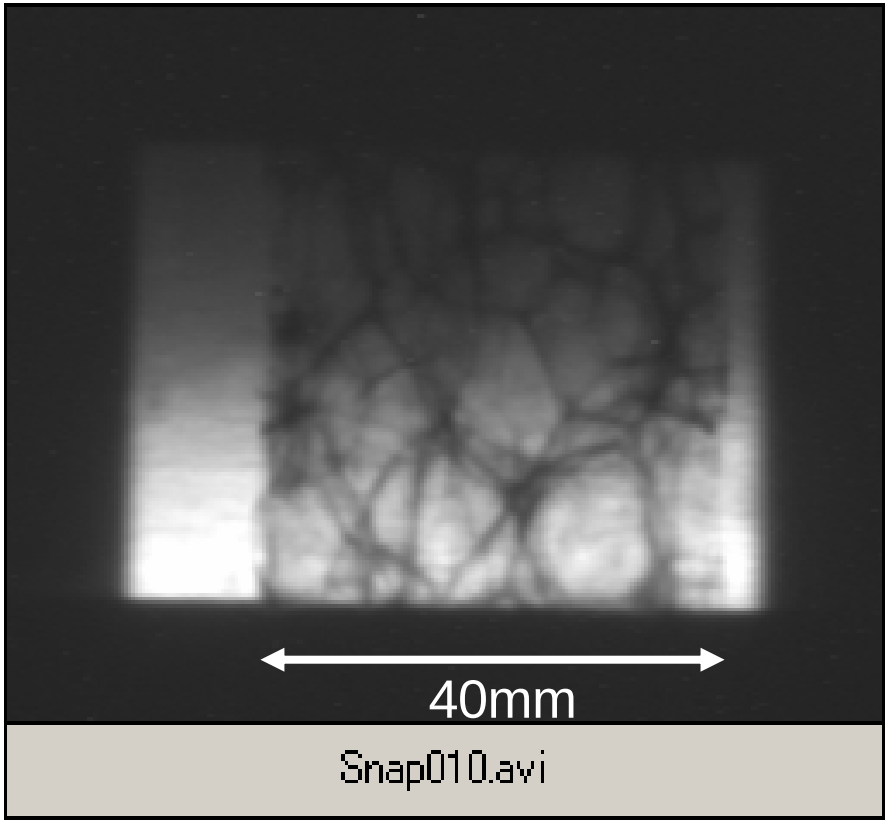

Different decay process can be clearly distinguished.

<BL19B2>
20keV, Si(311)

<CCD Camera>
1000 x 1000pixel - 30Hz
C8800 and 4inch X-II
8.0 μm pixel size, 80msec
(Hamamatsu photonics K.K.)

In-situ Dynamic image of foam aluminum monitored by X-ray radiography for 3D-analysis

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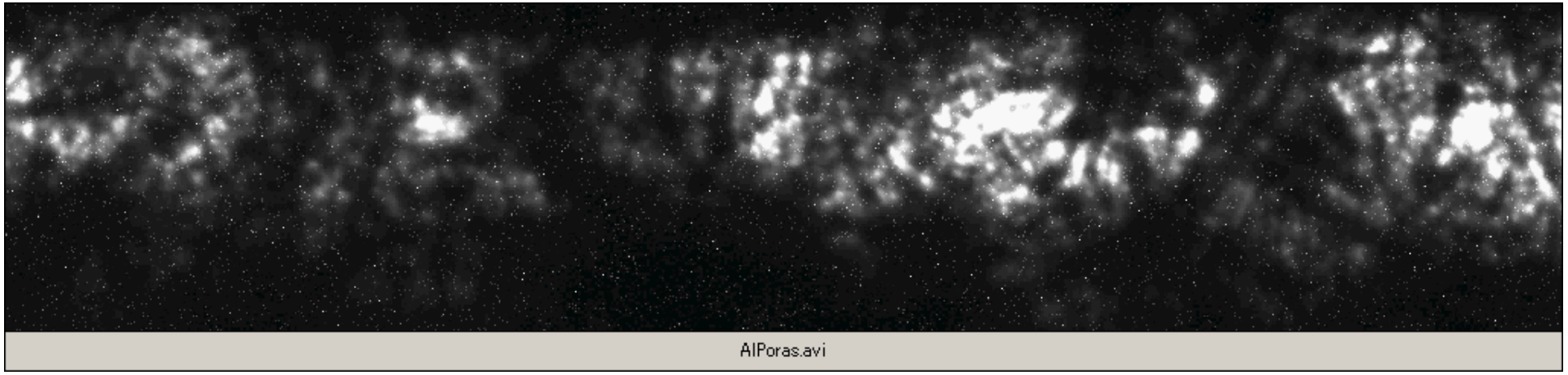

The rotation center of the sample is uncertain somewhere in the current experiment.

↓

It is necessary to improve the method of deciding the rotation center.

<BL16B2>

18 keV, Si(111) double crystal

<CCD camera>

2048×2048 pixel–12bits
MegaPlus ES4.0/E
8.0 μm pixel size, 90msec
(Nippon Roper K.K).

Each image is constracted by 11image.

The panorama method was adopted.

Appl. Example 3: New surface Structural Analysis by X-Ray Diffuse Scattering and Reflection Mode XAFS Combinations

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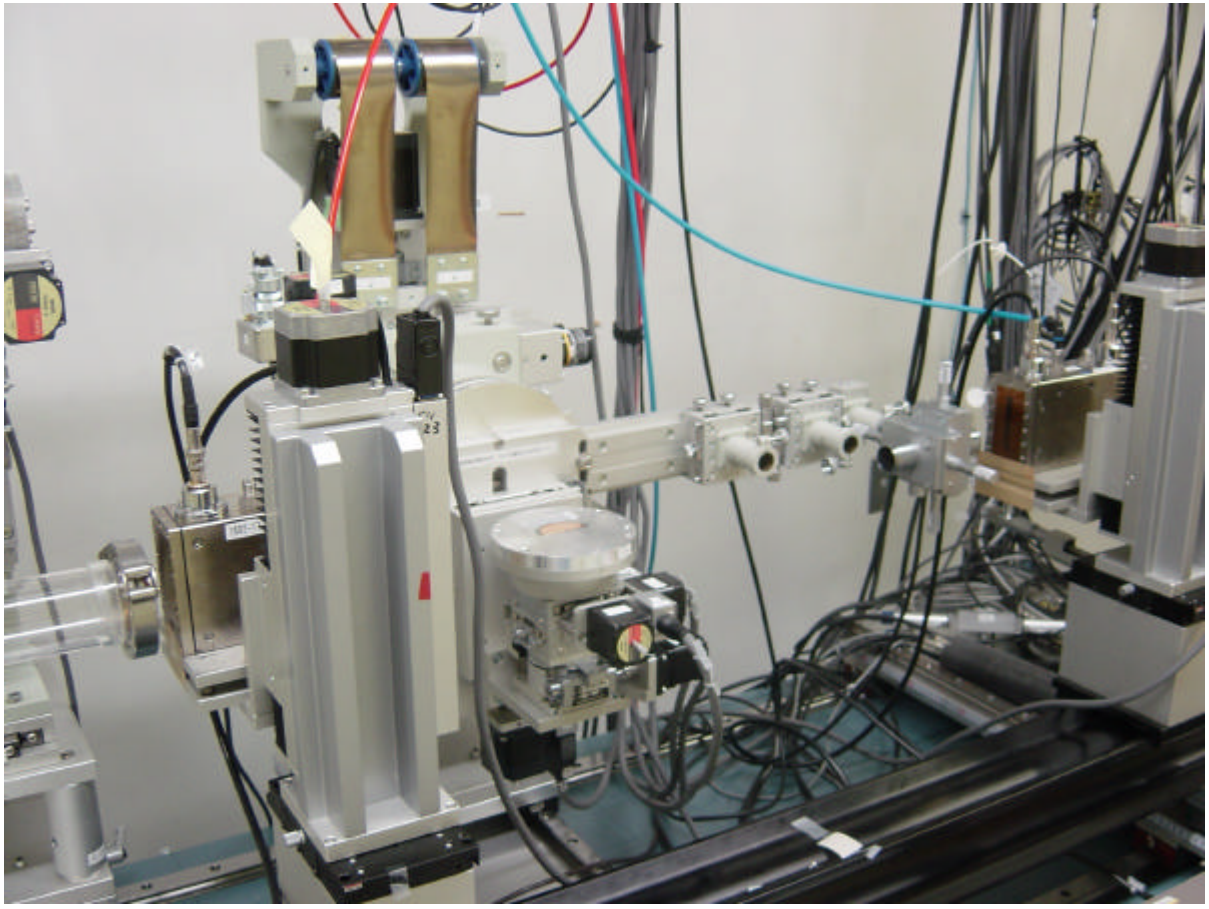

Diffuse Scattering and Reflection mode XAFS measuring system.

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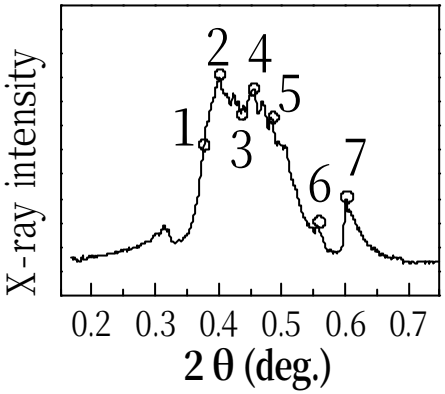
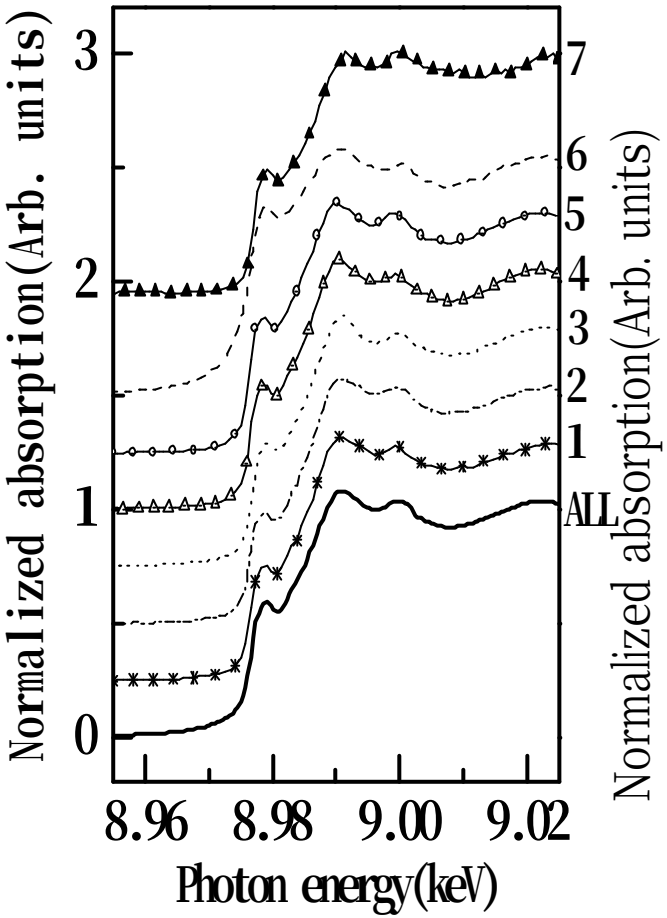
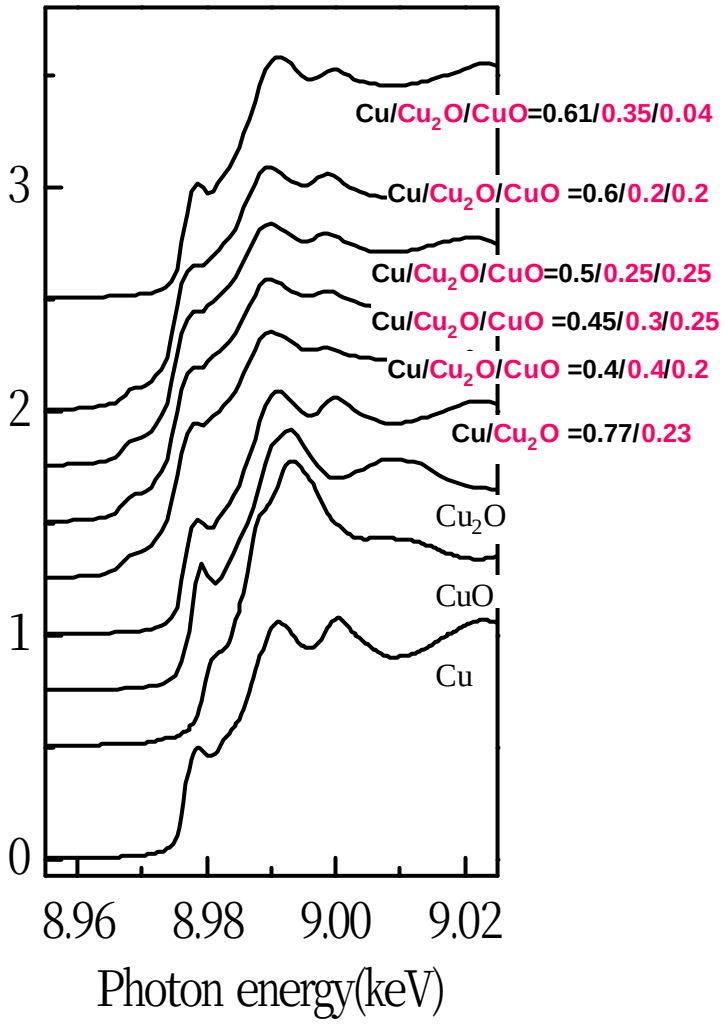
The X-ray diffuse scattering profil of Cu film spattered on the Si(100).



The reflection mode Cu *K-edge* XANES of Cu film at the points of 1 to 7 in the X-ray diffuse scattering profil.



LC-XANES Fit by WinXAS2.33



The spectrum that the ratio of metal Cu and the oxides is different according to each measurement point (1 to 7)

This result is suggested that the spectrum contain more detailed surface information like spots on the surface etc. compared with the usual reflection mode XAFS.
We want to name this method DS-XAFS (Diffuse scattering mode XAFS).