Chemical Physics of Non-Crystalline Materials　Prof. **Eiichiro Matsubara** (1999.9~)

【Staff Members】

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【Research Activities】

Our laboratory has three main topics: (1) structural stability of metallic glass at phase transition temperature, (2) advancing of X-ray fluorescence holography and (3) development of titanium oxide photo catalyst with high efficiency. Dr. T. Ichitsubo and Dr. M. Sakurai carried out the topic (1). Associate professor K. Hayashi carried out topic (2).

(1): Focusing on the fact that ultrasonic (sub/low-MHz) vibrations (i. e., external periodic strain) accelerates crystallization of some bulk metallic glasses,1) we discussed the nature of glass transition and structural stability of metallic glasses. For Fe-Ni-B amorphous alloys, we also examined α-Fe nanocrystallines precipitation process from structural view point.2) We are investigating the correlation between amorphous structure and crystallization behavior depending on the compositions, in collaboration with Prof. Hiroitsu's group, Osaka University.

(2): We have advanced X-ray fluorescence holography technique since 2000.3) In 2004 we proposed quantitative analysis of X-ray fluorescence holography, using inverse Fourier transform from a selected atomic image and at least mean square fitting, in stead of Barton algorithm conventionally used. The technique produces accurate interatomic distances, and we applied it to multiple energy x-ray holograms. The interatomic distances of neighboring atoms around a fluorescing atom were estimated from the 16 experimental holograms of a Au single crystal and most of them were in good agreement with the actual values within an error of 0.3%.

(3): With the aim of enhancement of photocatalytic ability of TiO_2 films, we have succeeded the fabrication of single-phase anatase film, and the formation mechanism of anatase in thin films was successfully explained in terms of the strain-energy releases by its formation from the amorphous titania.4,5) Further progress for the high efficiency photocatalytic ability will be achieved by combining this method with partial sulfurization of the titania film

1. Ichitsubo T, Matsubara E, Kai S, Hirao M;
Ultrasound-induced crystallization around the glass transition temperature for $Pd_{40}Ni_{40}P_{20}$ metallic glass,
Acta Mater., 52(2), 2004, 423-429.

2. Matsubara E, Tanaka S, Makino A, Chiang TH;
Crystallization behavior of alpha Fe in Fe84Nb7B9 and Fe85Nb6B9 amorphous alloys,
Mater. Trans., 45 (4), 2004: 1199-1203.

3. Takahashi Y, Hayashi K, Matsubara E

Development and application of laboratory X-ray fluorescence holography equipment
Powder Diffraction, 19(1), 2004, 77-80

4. Nakamura T, Ichitsubo T, Matsubara E, Muramatsu A, Sato N, Takahashi H;
Preferential formation of anatase in laser-ablated titanium dioxide films,
Acta Materialia, 53 (2), 2005, 323-329.

5. Nakamura T, Matsubara E, Sato N, Muramatsu A, Takahashi H;
Study on fabrication of titanium oxide films by oxygen pressure controlled pulsed laser deposition,
Mater. Trans. 45 (7), 2004, 2068-2072.

【Plan】

We have two plans concerning to first objective of IMR "nano-structured metallic materials". (1) Development of nano-structured materials based on metallic glasses and super cooled liquid alloys. (2) Realizations of spectroscopy and imaging techniques using X-rays, electrons, neutrons.

(1): We will determine structure of metallic glasses and nano-crystalline materials using X-ray, especially synchrotron radiation, to clarify phase stability of metallic glass stability and nano-crystallization. Effect of additional elements on metallic glass stability and nano-crystallization will become clear through our experimental results, therefore we will be able to provide our enormous knowledge of metallic glasses to other research group preparing bulk metallic glasses. We will also study control of nanocrystalline structure using external field such as ultrasonic vibration inducing crystallization in the vicinity of glass transition temperature.

(2): We will apply the inverse Fourier method to the holograms of binary semiconductor single crystal, such as SiGe, and will evaluate quantitative local lattice distortion. Moreover, we plan some neutron and electron microscopy works related to atomic resolution holography.