

Study about the mechanisms of action between in production of ROS by trace elements and inflammation processes using SR micro beam

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Allergy is one of common diseases. While the cause of allergy remains unclear, there are some indications that excessive accumulation of essential element, and sometimes, incorporation of toxic foreign elements in cells aggravate allergic reactions. Transition metals induce metal allergy, and it is known that transition metals seem to play an important role in production of reactive oxygen species (ROS) and free radicals, it can be hypothesized that reactive oxygen may play a causative factor in allergic reaction.

In order to detect the metallic elements in cultured cell lines, we used the established human cell lines, HL60. HL60 can be induced to differentiate into neutrophils by DMSO. Several leukocytes release several mediators, which play important roles in mechanisms of allergy. ROS induce various types of oxidative damages considered to be important in inflammation processes. We had an experimental system to measure biologically generated ROS-induced intracellular oxidative damage. We, however, did not have any method to simultaneously measure various kinds of intracellular transition metals seem to be more important for the production of ROS as electron donor. Hence, the mechanisms of intracellular distribution and chemical state of transition metals in relation to biological events have not yet been clarified so far.

In the present study, HL60 was used for measuring intracellular superoxide anion (O_2^-). The differentiated HL60s have similar functions to those of their respective counterparts. We determined that cell line, and then investigated the intracellular conditions of transition metals and ROS induction to clarify their relations. Using

these techniques, we might be able to observe the states of trace elements in mechanisms of O_2^- release in related to with Fenton-reaction. The spectrum of the PMA stimulation is shown between those two spectra obtained at reference materials [Fig 1(a), (b)]. It showed that there are both Fe^{2+} and Fe^{3+} in that sample. After stimulation, chemical state of iron shifted to Fe^{3+} .

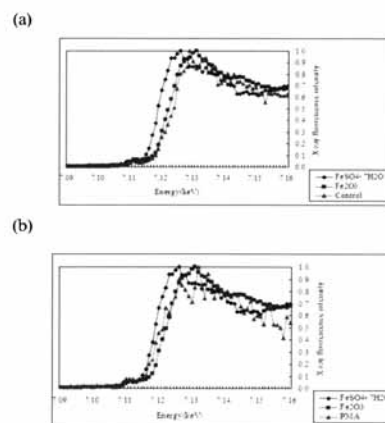


Fig 1. Blue and redlines show the XANES spectra of $FeSO_4 \cdot 7H_2O$ and Fe_2O_3 powder, respectively, as reference materials. These are the comparison of Fe K-edge XANES spectra between the sample and the reference materials ($FeSO_4 \cdot 7H_2O$ [Fe^{2+}], and Fe_2O_3 [Fe^{3+}]). (a) Control, (b) PMA stimulation. The beam size was $0.25\mu m^2$, and the incident beam energy was changed from 7.10 to 7.16 keV. The XANES spectrum of the samples showed a substantial difference from those of the reference materials $FeSO_4 \cdot 7H_2O$ and Fe_2O_3 .

Local structure analysis of diluted magnetic semiconductor $Zn_{1-x}Mn_xTe$ using X-ray fluorescence holography

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Ternary mixtures $Zn_{1-x}Mn_xTe$ is one of the so-called diluted magnetic semiconductors, which have for long attracted much attention due to their striking magnetic and magneto-optical properties [1]. Various properties of this intermediate phase between magnetic and semiconducting materials can be controlled by a change of the concentration, though the concentration ranges are in some cases very limited. However, recent technology of nanoscience enables to obtain the stable phase in a wider composition range, and apply them to fabricate new electronic devices.

The structure of $Zn_{1-x}Mn_xTe$ has for long been believed that cations Zn^{2+} are randomly replaced by magnetic ions Mn^{2+} in its zinc-blend structure. This speculation was based on an X-ray diffraction result [2] that its lattice constant linearly changes with the Mn concentration (Vegard's law). The XAFS results, however, showed almost unchanged Mn-Te (0.272 nm) and Zn-Te (0.264 nm) bond lengths (Pauling's rule) over a wide concentration range up to $x = 0.65$ [3]. This discrepancy led us to a new question how the larger $Mn(Te_{1/2})_4$ tetrahedra can be squeezed into the smaller ZnTe lattice, or how the structure is self-organized to reduce this stress and then to form the stable phase.

X-ray fluorescence holography (XFH) is a new technique that allows us to visualize three-dimensional local structures around a specific element [4]. In this XFH study, we tried to obtain three-dimensional structural views around both the Zn and Mn elements to directly solve the above question.

The Zn and Mn K_{α} fluorescence X-rays can be collected using an APD detector with a cylindrical graphite energy analyzer. The

XFH data were recorded at several incident X-ray energies of 8.5-16 keV by rotating two axes ($0^\circ \leq \phi \leq 360^\circ$, $0^\circ \leq \theta \leq 70^\circ$) of a single-crystal $Zn_{0.6}Mn_{0.4}Te$ sample.

Figure shows an example of the XFH pattern on the $\theta - \phi$ plane measured using the incident X-ray of 13 keV and obtained as the residuals of the fits of 6th polynomial equations to the ϕ dependence of the Zn K_{α} XFH signals. In the figure, X-ray standing wave lines are clearly seen. From the obtained XFH data, we will calculate the three-dimensional image of the local structure around the Zn and Mn elements.

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