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# Development of XANAM

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## Introduction

STM and NC-AFM can provide atomic-scale information on surface structures. However, they could not give the elemental information directly. Previously, we observed the force change induced by the X-rays with their photon energy around the absorption edge of sample surface's element[1-3]. Since the absorption edge is element-specific, the X-ray aided Noncontact Atomic Force Microscopy (XANAM) can be realized. In this paper we have measured the force as a 2 dimensional function of X-ray energy and the tip-surface distance, namely X-ray energy dependent force curve, in order to clarify the mechanism for X-ray induced force change. We found the force curve is also strongly affected by X-rays and also the force curve is governed by two key factors.

## Experimental

The experiments were performed with a home-made XANAM system which is composed of UHV NC-AFM and a 4 axes sample-AFM-tip stage to adjust the sample position relative to the X-ray beam. Piezo-thin film AFM cantilevers (NIKON) with resonance frequency of 90~100 kHz were used, which were then controlled by a SPM controller produced by Nanonis. We used Au covered Si wafer samples were prepared by the vacuum evaporation of Au.

## Results and Discussions

Fig .1 shows typical data of X-ray energy dependent force curves on the Au-covered surface. The X-ray energy step was about 1 eV around the Au $L_3$ absorption edge. Each force curve is an average of 3 independent measurements. To prevent a severe damage to the cantilever, it was oscillated with a constant excitation mode of NC-AFM operation. At the absorption edge (indicated by an arrow), the force curve's feature changed drastically. Interestingly above the absorption edge, the curve became featureless with a steep rise during the approach and a clear minimum point disappeared. On the other hand, the force curve on a bare Si surface did not change its shape by the X-ray irradiation around the Au $L_3$ absorption edge energies.

We have proposed a XANAM mechanism that the alteration of interaction between the cantilever tip and the sample surface is induced by the modification of the bonding electron density between them by the transition from the core electron to the bonding state. The force curve dependence on X-ray energies supports the above proposal.

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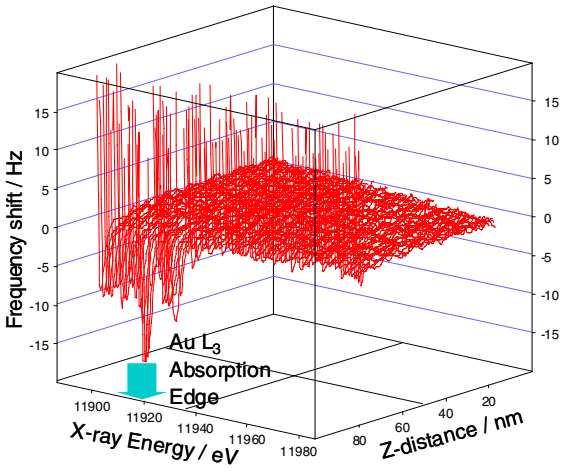


Fig. 1 Force dependency measured along NC-AFM tip-surface distance (force curve) as a function of the X-ray energy on a Au deposited Si substrate; $f_0$=91.0 kHz, A= 1.0 nm

## References

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