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X-ray fluorescence imaging of combinatorial Pt-Ta-Ru alloy library

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Introduction

Combinatorial synthesis is a modern technique that has been applied to efficiently seek out promising candidates for specific materials applications [1]. Using this technique, various samples are prepared under very different conditions as an array on a single substrate. The technique requires efficient methods of characterization. In this study, X-ray fluorescence imaging was applied to quickly observe the chemical composition of an inhomogeneous Pt-Ta-Ru ternary alloy system.

Experimental

Figure 1 shows a sketch of the present sample, which was prepared via a combinatorial method. Metallic Pt, Ta and Ru are evaporated by using an ion-beam system so that the chemical composition is graded on a Si(100) substrate. The layer thickness is designed to be ca. 30 nm. Details of the instrumentation of the present X-ray fluorescence microscope have been described elsewhere [2]. The sample was broken into 3 parts, and the viewing area was set at 13mm × 13mm in order to observe substrate *A,* which includes the ternary alloy area. The typical exposure time for one image was 10 sec.

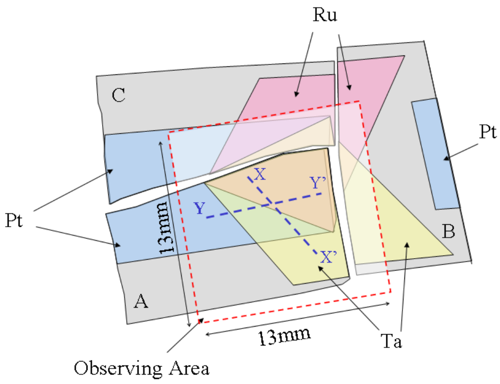

Figure 1 Schematic view of combinatorial Pt-Ta-Ru ternary alloy thin film. The preparation is such that gradation of the chemical composition depends on the location on the substrate.

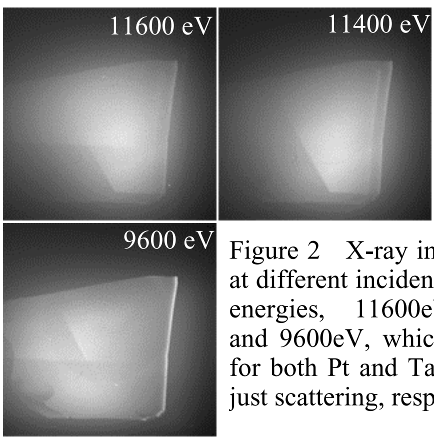

Figure 2 X-ray images obtained at different incident X-ray photon energies, 11600eV, 11400eV, and 9600eV, which give images for both Pt and Ta, only Ta, and just scattering, respectively.

Results and Discussion

Figure 2 shows the X-ray images obtained when the primary photon energy is 11600eV (above the Pt LIII edge), 11400eV (below the Pt L III edge but above the Ta LIII edge), and 9600eV (below the Ta LIII edge). At 11600eV, both Ta and Pt are excited, but only Ta X-ray fluorescence is seen at 11400 eV. One can determine the atomic ratio of Pt and Ta at each point on the substrate by analyzing those images. Drawing line profiles, as shown in Fig.3, is sometimes useful for evaluating the gradation. Unfortunately, it was difficult to observe X-ray fluorescence from Ru, because both the K (22117eV) and L absorption edges (2800~3200eV) are beyond the range of the present system. On the other hand, 2D X-ray diffraction imaging [3] is extremely important for obtaining specific materials parameters from such a combinatorial library. Further studies are under way. The authors would like to thank Drs. H. Sawa, Y. Wakabayashi, Y. Uchida, for their assistance and advice during the experiment.

References

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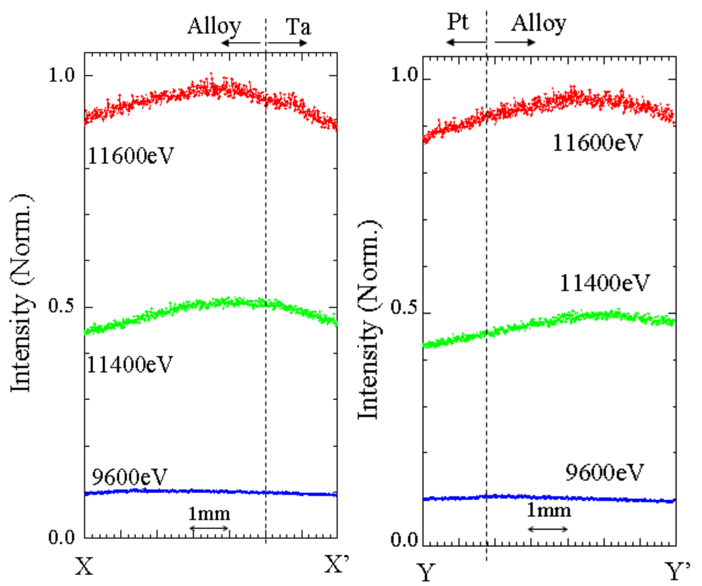

Figure 3 Line profiles along X-X' and Y-Y' (as indicated in Fig.1). Chemical composition grading is evaluated by those data.