ACCURATE REFINEMENT OF MATERIAL STRUCTURE WITH TOMOGRAPHY ANALYSIS

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Summary: New methods of tomographic analysis have to be developed for the investigation of specified material structure besides the 3D visualization with various tomography techniques. 3D-SIMS tomography analytics was developed to provide diffusion information of the composition at an interface of coating and substrate. An Edge dilatation method was used with XCT to accurately isolate impurities from the pore in an alloy.

1. INTRODUCTION

Although tomographical imaging can rely on the routine work provided by different reconstruction software, it is only limited to see the data collected with three dimensional (3D) view, and detailed information of materials structures cannot easily exhibited without knowledgeable exploration and investigation. For problem oriented materials research, it is of great importance to develop new analysis methods to accurately refine the structures from reconstructed tomography. Nowadays, new technology and methods with 3D capability are emerging based on traditional microanalysis techniques to investigate the morphology, composition, orientation, strain etc. of materials in various dimensional scales. Some common research objects in 3D, for example the shape and distributions of impurities in alloys and the composition and its concentration at the interface, need both new 3D technology and more detailed analytics. We present two methods developed for tomography analysis to accurately refine diffusions at the interfaces and the impurity in engineering alloys

2. EXPERIMENTAL METHOD

Combining imaging and sputtering with interlaced mode, layered Time of Flight Secondary Ion Mass Spectrometry (TOF-SIMS) imaging can be reconstructed in 3D view to investigate the distribution of chemical composition. A plug-in for the open source software ImageJ was developed independently, which can convert SIMS stacks to be 3D viewed in ImagJ. The plug-in can directly read the SIMS data and present the spatial distribution and correlation of each component of the research object. To study diffused interface, new 3D imaging approach within ImageJ is developed to separate the diffused species through the interface.

X-ray computed tomography (XCT) is a powerful tool to reveal internal structures and defects of wide range of materials. It is of very important for safety evaluation to accurately identify the size, shape, quantity, distribution of the impurities and voids in engineering alloys. The XCT may present different structure with a similar gray scale in the X-ray imaging and after 3D reconstruction. When extracting the impurities in alloy by 3D image

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processing analysis, the conventional gray scale separation recognized the gray level of impurities the same as the edges of the voids, which leads to distorted analysis results of the impurities. By the method of edge expansion in 3D image processing, the gray value of the void edge changed but the gray level of the impurities remains unchanged.

3. RESULTS

By Gaussian convolution of the 3D-SIMS data, the counts density on every slice was transformed into quasi-concentration space. In terms of the ion imaging of CsAl+ in the coating, diffused Al with low concentration at the interface between the ceramic coating and Zircaloy substrate were clearly observed in both as-deposited and annealed states.

It is hard to distinguish impurities from the reconstructed XCT 3D view of the pore structure by using the normal gray scale separation, which covered also the range of impurities. The overlapped gray scale of the pore edge can be replaced by its intrinsic gray with the dilatation of pore. After the imaging processing, the impurities was clearly isolated and shown as their original shape and statues. Additional information of impurities was then provided based on accurate statistics.

References

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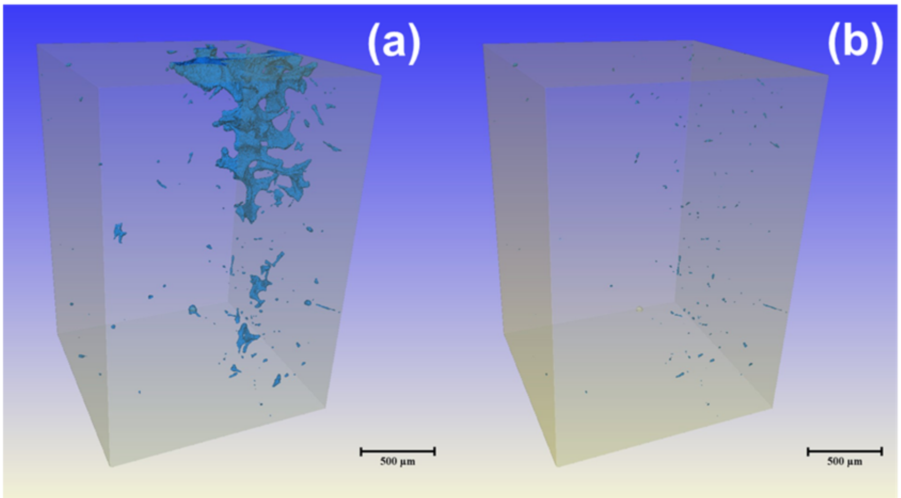

Figure 1 (a) Normal image processing result without separation of voids and impurities, (b) accurately refinement of the isolated impurities with edge dilation