An analysis of non-ferrous materials (parts) of automobiles using precision analysis equipment

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A global warming and depletion of energy resources have intensified. The automobile fuel economy and emissions regulations have been tightened. Developed countries (US, Japan, Germany, etc.) are developing non-ferrous materials (parts) technology that improves fuel efficiency and minimizes environmental pollution of automobiles [1, 2]. It is necessary to understand the microstructure, crystal structure, and microstructure of non-ferrous materials (parts) having excellent materials such as high heat resistance and high elasticity (tungsten(W), titanium(Ti), etc.) [3]. Therefore, this paper introduces the analysis of non-ferrous materials (parts) using precision analysis equipment (scanning electron microscope, scanning transmission electron microscope, focused ion beam equipment, atomic microscope, etc.).

Non-ferrous materials (W, Ti) were DC magnetron sputtered in vacuum to check the microstructure and crystal structure changes on a general substrate (silicon wafer). In addition, the
microwave plasma chemical vapor deposition (MPCVD) method was used to determine the change over time in the heat-resistant conditions.

Two kinds of test specimens were prepared by sputtering non-ferrous materials (W, Ti) on the substrate to a thickness of about 1um. The conditions are deposited by time (0.5, 1, 2 h) at the temperature (600 ° C) and the properties of non-ferrous materials are compared.

Non-ferrous materials (W, Ti) were analyzed using precision analysis equipment. Surface and cross-section are scanning electron microscope (SEM), microstructure milling is ion beam equipment (FIB), microstructure of cross section is scanning transmission electron microscope (STEM), surface structure is atomic force microscope (AFM).

The surface and cross-section states were compared and observed with a SEM. As a result, the W surface seemed to be overlapped with a similar shape of crystal grains. The cross-section had a rectangular column with rounded ends. On the other hand, the Ti surface seemed to have a similar shape of grains separated. The cross -section had a needle-like columnar structure. This can be seen in Figures 1 and 2.

The surface structure roughness was observed by an AFM. As a result, the W surface had an average roughness value of about 3.4 nm. On the other hand, the Ti surface had an average roughness value of about 9 nm. The difference is about three times. This can be seen in Figures 3.

Non-ferrous materials (W, Ti) were ion-gallium (Ga) milled using a FIB equipment. The microstructure and the crystal structure were observed under high heat-resistant temperature condition by a STEM. As a result, the tungsten was already coalesced in 0.5 h to form a thin film rapidly, and the particle density was reduced, and the total area was almost 100%. Also, some voids existed at the interface, but they were smooth. On the other hand, the Ti surface was formed fine particle in 0.5 to 1h. Coalescence occurred in 2 h, the thin film was formed slowly, the particle density was reduced, and the total area was almost 100%. Also, many voids existed at the interface, and they were rough surface. This can be seen in Figures 4, 5 and 6.

The following conclusions were obtained with precision analysis equipment for non-ferrous materials (W, Ti). Comparing the particle density of non-ferrous materials (W, Ti) over the deposition time, it was found that W is higher than Ti. Higher particle densities indicate less initial roughness of the particles. It is easy to form a thin film across an energy barrier. The result is the same of a SEM and an AFM. In the case of titanium having a low particle density, many voids are formed at the interface between the particles and the particles. The force at the interface is small. A separation is expected to occur easily in frictional forces. The result is the same of a FIB and a STEM. It is important to use a variety of precision analyzers to study microstructure and crystal structure.

References :
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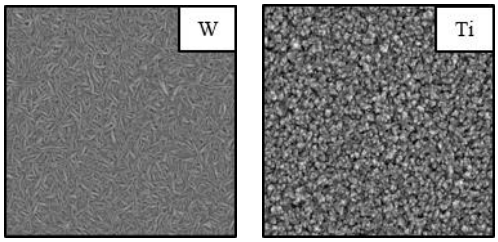

Fig.1 SEM images of the surface.

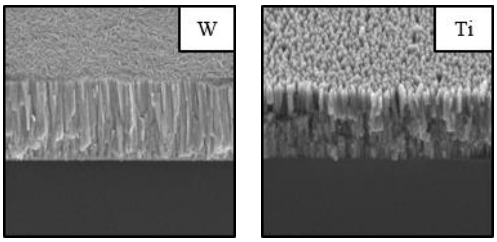

Fig.2 SEM images of the cross-section.

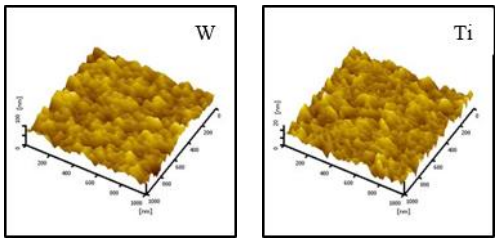

Fig.3 AFM images of the surface.

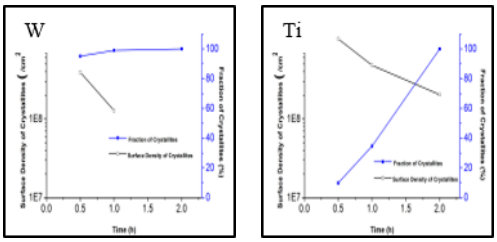

Fig.4 Surface density and fraction of the graph.

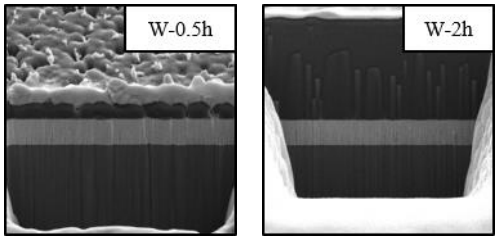

Fig.5 FIB images of the cross-section.

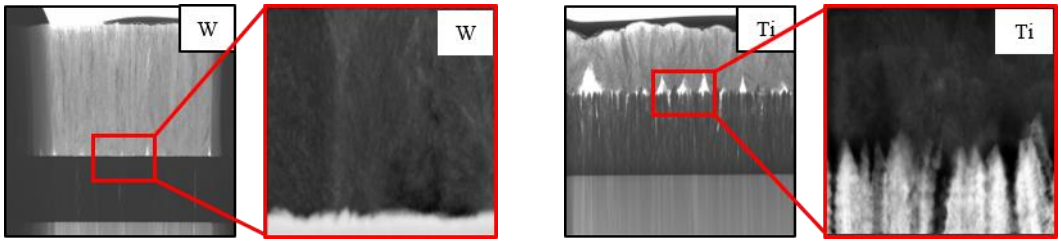

Fig.6 STEM images of the cross-section.