

temperature. There exists little scientific literature on this system and hence there is scope to develop this field. It has been found from the existing studies that an equiatomic refractory alloy has broadly a BCC structure with some compositional variation in the as-cast structure. In many cases ordering phenomena was not evident from X-Ray powder diffraction data, but was found through HRTEM electron diffraction in Al-Co-Cr-Fe-Ni HEA.

As the above-mentioned refractory materials have melting point of nearly 3000°C, the equiatomic WMoNbTa alloy was prepared through arc melting in argon atmosphere. The starting metal powders all had purity above 99.95 percent. First a 5-gram pellet was made from the well-mixed powders by hydraulic press. Later the pellet was melted under arc five times each for 2 minutes. Each time the sample was melted, it was turned upside down for even better mixing of elements. This was probably a better method than a previous report where metal chips and powder were melted together in the arc-melting furnace, which might remove some small chips when the arc strikes the mixture. After this the samples were wrapped into tantalum foils and sealed inside tantalum ampules. The inside of the ampule had Argon atmosphere and it was annealed at 1800°C for a week. The grain size distribution provides us with 50 micron grains that could be studied for diffuse scattering experiments.

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**Keywords:** high-entropy alloy, coloring problem, refractory alloy

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**Structural analysis of metal nano-particles prepared by leaching** Reiko Murao,<sup>a</sup> Kazumasa Sugiyama,<sup>a</sup> Satoshi Kameoka,<sup>b</sup> An-Pang Tsai,<sup>b</sup> <sup>a</sup>Institute for Materials Research, Tohoku University, Sendai (Japan). <sup>b</sup>Institute of Multidisciplinary Research for Advanced Materials, Tohoku University, Sendai (Japan). E-mail: r\_murao@imr.tohoku.ac.jp

Catalytic fine particles can be obtained by the leaching of a variety of alloy powders using alkali or acid solutions [1]. During the leaching process, the structure of a parent alloy sample is decomposed and the X-ray diffraction pattern of resultant fine particles is usually very broad and diffuse. These features could be generally attributed to the small size of crystallite and the highly disordered structure [2]. To clarify structural features of such fine particles, the analysis of atomic pair distribution function (PDF), calculated from the total X-ray scattering measured by high-energy X-ray source, is suggested to be one of effective methods. However, high resolution PDF is not enough to discuss the structure around a specific element in the case of multi-component alloy system. In this context, the anomalous X-ray scattering (AXS) method [3] is a powerful tool to provide environmental structural information around a target element, not only in nearest neighbor but also in middle range region. Present paper demonstrates some examples of structural analysis for fine particles by anomalous X-ray scattering.

Structures of Raney Ru(Ni) fine particles prepared from Al<sub>13</sub>(Ru,Ni)<sub>4</sub> alloy powder by alkali-leaching (NaOH) were investigated by the high-energy X-ray scattering and AXS measurement at the Ni-K absorption edge. Ordinary PDF for Raney Ru indicates atomic correlation similar to that for fcc-Ru. However, a correlation peak at about 0.2 nm, which could not be described by the atomic arrangement in the fcc-typed structure, is developed as a function of the Ni content. Additionally this interesting correlation could be clearly observed in the environmental PDF around Ni. These experimental results support the partial oxidation of Ni so as to realize the Ni-O pair in the observed

PDFs. In middle range region of the environmental PDF, Ni-Ni(Ru) pairs with respect to the hcp-typed structure could be identified. These results suggest that the atomic rearrangement of Ni toward hcp-typed structure together with the partial oxidization was realized during the leaching process.

Structure of Pt/Cu fine particles prepared from a Cu<sub>3</sub>Pt alloy powder by acid-leaching (HNO<sub>3</sub>) was also studied by anomalous X-ray scattering. The ICP analysis indicates the Pt/Cu ratio of the obtained fine particles is about 85/15. Although the overall features observed in PDF is rather similar to that of fcc-Pt, the environmental RDF around Pt shows a correlation of the Pt-O pair at around 0.2 nm. Therefore, partial oxidation of Pt in the fine Pt/Cu alloy particles is readily suggested.

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**Low-temperature plasticity of magnesium alloy AZ31 with different microstructure**

V.V. Pustovalov,<sup>a</sup> Y. Estrin,<sup>b</sup> P.A. Zabrodin,<sup>a</sup> I.S. Braude,<sup>a</sup> T.V.Grigorova,<sup>a</sup> N.V.Isaev,<sup>a</sup> V.S.Fomenko,<sup>a</sup> S.E.Shumilin,<sup>a</sup> <sup>a</sup>Institute for Low Temperature Physics and Engineering, Ave Lenin 47, Kharkov 61103, (Ukraine). <sup>b</sup>APC Center of Excellence for Design in Light Metals, Department of Materials Engineering Monash University, Clayton, Vic.(Australia) E-mail: pustovalov@ilt.kharkov.ua

The feature of plastic deformation of magnesium alloy AZ-31 by tension in the temperature range 4.2-295 K are examined depending on microstructure after squeeze casting (SC) and severe plastic deformation (SPD) via hot rolling and equal channel angular pressing. The SPD processing results in decrease of grain size and formation of a texture for basal dislocation glide. The microstructure of the samples for tension that were cut from the initial SC and SPD materials were also monitored by X-ray diffraction. The ratio of the integrated intensities of the (10.0), (00.2) and (10.1) reflections along and perpendicular to the sample axis are ~1.1 and 1.4 for SC and SPD samples, respectively. The integrated intensity of the (00.2) reflection for a sample from the SPD material is greater by an order of magnitude than for a sample from the initial SC material. These ratios of the integrated intensities indicate that the flat sample for tension retained the texture of the initial material, and its longitudinal axis coincides with the direction of rolling and pressing. The coherent scattering regions for SC and SPD derived from the Hall plots for the basal plane are 150 and 0.2 μm, respectively. These estimates, as is customary in these cases, are lower than the average grain size obtained by transmission microscopy, but the relative change in the coherent scattering region in the SC and SPD samples correlates with significant reduction in the grain size owing to rolling and pressing of the material. It is found that in the temperature range 4.2-25 K the plastic deformation becomes unstable (serrated) with stress jumps in the SPD alloy greater than in the SC one. The temperature dependence of yield stress of this alloy is typical of thermally activation unpinning of dislocations from short range obstacles. Correlation of yield stresses for SPD and SC samples at given temperature is explained by hardening due to refinement of grain size and owing to favorable texture. The work hardening coefficient to alloy decreases a grain size but the ductility (strain to fracture) increases due to texture. The strain rate sensitivity of flow stress at T≤100 K does not