マテリアル先端リサーチインフラ利用報告書
ARIM User's Report

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課題データ / Project Data

課題番号 Project Issue Number	22TU0027
利用課題名 Title	Crystallization behavior of metallic glasses
利用した実施機関 Support Institute	東北大学 / Tohoku Univ.
機関外・機関内の利用 External or Internal Use	外部利用/External Use
ARIM半導体基盤PF 関連課題 Related to ARIM-SETI	指定なし / No Designation
横断技術領域 Cross-Technology Area	計測・分析/Advanced Characterization
重要技術領域 Important Technology Area	高度なデバイス機能の発現を可能とするマテリアル/Materials allowing high-level device functions to be performed
キーワード Keywords	バルクアモルファス合金,電子顕微鏡/Electron microscopy

利用者と利用形態 / User and Support Type

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共同利用者氏名 Names of Collaborators Excluding Supporters in the Hub and Spoke Institutes	
ARIM実施機関支援担当者 Names of Supporters in the Hub and Spoke Institutes	
利用形態 Support Type	機器利用/Equipment Utilization

利用した主な設備 / Equipment Used in This Project

利用した主な設備 Equipment ID & Name	TU-516：分析電子顕微鏡 TU-517：透過電子顕微鏡

報告書データ / Report

概要（目的・用途・実施内容） Abstract (Aim, Use Applications and Contents)	Structural features of the $Pd_{42.5}Cu_{30}Ni_{7.5}P_{20}$ and $Pt_{42.5}Cu_{27}Ni_{9.5}P_{21}$ metallic glasses are studied in the present work by high-resolution transmission electron microscopy. The results indicate that $Pd_{42.5}Cu_{30}Ni_{7.5}P_{20}$ is a true bulk glass-former containing no crystalline particles/nuclei, while $Pt_{42.5}Cu_{27}Ni_{9.5}P_{21}$ is a crystal growth-controlled type bulk glass-former which contains nanoparticles of about 1 nm size with a different chemical composition. These structural differences are manifested in room-temperature mechanical properties. Thermodynamic calculations are also used to support the observed features.
実験 Experimental	Ingots of the $Pd_{42.5}Cu_{30}Ni_{7.5}P_{20}$ and $Pt_{42.5}Cu_{27}Ni_{9.5}P_{21}$ alloys (the compositions are given in nominal atomic/molar percentages) were prepared by smelting of pure elements of 99.9 % mass purity. The structures of the samples were examined by conventional X-ray diffractometry (XRD) with CuKa radiation. Transmission electron microscopy observation, including collection of selected-area electron diffraction (SAED) and nanobeam diffraction (NBD) (1 nm probe size) patterns were carried out using a TOPCON EM-002B microscope operating at 160 kV. Scanning TEM (STEM) observation and the energy-dispersive X-ray (EDX) analysis were performed using JEOL-ARM200F microscope operating at 200 kV. Oxygen content in the studied glassy alloys was measured by using infrared absorption (IA) after fusion under He gas.
結果と考察 Results and Discussion	Significant difference in fine structure of the $Pd_{42.5}Cu_{30}Ni_{7.5}P_{20}$ and $Pt_{42.5}Cu_{27}Ni_{9.5}P_{21}$ metallic glasses was found (Figs. 1 and 2). The $Pd_{42.5}Cu_{30}Ni_{7.5}P_{20}$ metallic glass is a true bulk glass-former containing no crystalline particles/nuclei (Fig. 1), while the $Pt_{42.5}Cu_{27}Ni_{9.5}P_{21}$ metallic glass contains cF4 (partially ordered as cP4) nanoparticles (Fig. 2) both in bulk and ribbon form. This peculiar structure is rather the origin of much higher plasticity of Pt-based BMGs compared to Pd-based ones in general, and in the present case. Moreover, the microstructure analysis with a complex mathematical approach provided accurate data and enlightened the structure features of a known metallic glass. The analysis of EDX maps indicated that these nanoparticles are enriched in Cu and Ni and depleted in Pt and P. Low spatial correlation with O indicated that these nanoparticles are not oxides. Thermodynamic calculations support the observed features.

図・表・数式 1
Figures, Tables and Equations 1

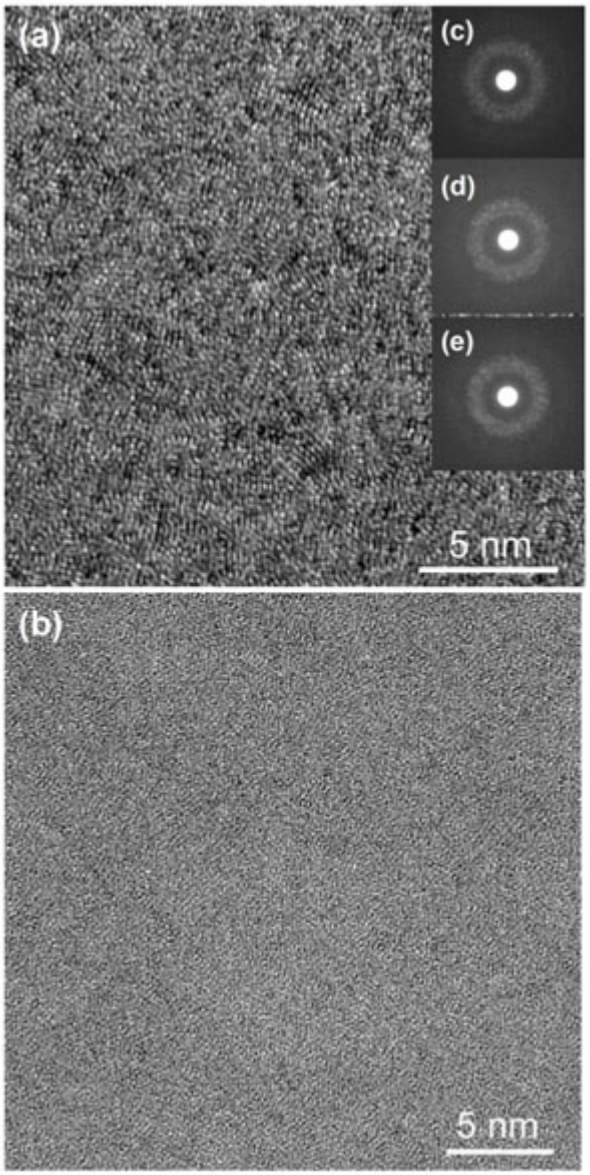
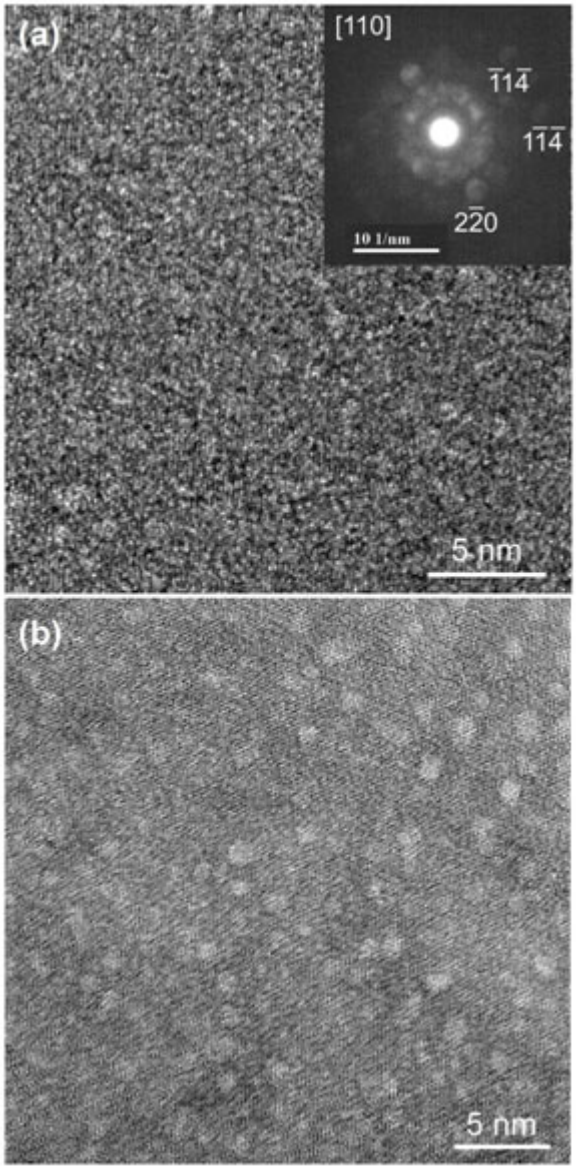


Fig.1 High-resolution TEM (HRTEM) (a) and STEM bright-field (b) images of the $Pd_{42.5}Cu_{30}Ni_{7.5}P_{20}$ metallic glass in ribbon form, together with a nanobeam diffraction pattern (inset).

図・表・数式 2 Figures, Tables and Equations 2	 Fig.2 High-resolution TEM (HRTEM) (a) and STEM bright-field (b) images of the $Pt_{42.5}Cu_{27}Ni_{9.5}P_{21}$ metallic glass in ribbon form, together with a nanobeam diffraction pattern (inset).
その他・特記事項（参考文献・謝辞等） Remarks(References and Acknowledgements)	

成果発表・成果利用 / Publication and Patents

DOI（論文・プロシーディング） DOI (Publication and Proceedings)	
口頭発表、ポスター発表および、その他の論文 Oral Presentations etc.	
特許出願件数 Number of Patent Applications	0件

特許登録件数 Number of Registered Patents	0件