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Phase stability of amorphous and crystalline phases in melt-spun $Zr_{66.7}Cu_{33.3}$ alloy under electron irradiation

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Abstract

Effect of electron irradiation on structural change of $Zr_{66.7}Cu_{33.3}$ alloy was examined. Metastable nanocrystalline f.c.c.- Zr_2Cu phase precipitated from the amorphous phase by electron irradiation, while b.c.t.- Zr_2Cu phase was crystallized by thermal annealing. The crystalline b.c.t.- Zr_2Cu phase was transformed to the nanocrystalline f.c.c.- Zr_2Cu phase through the amorphous state during electron irradiation.

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Keywords: Electron irradiation; Zirconium-based alloy; Phase stability; Crystallization; Amorphization

1. Introduction

Nanocrystalline structure is known to be very effective in improving mechanical and physical properties such as soft magnetic property and strength of crystalline materials [1–4]. Doi and Imura first reported the electron irradiation induced crystallization in Ni-based amorphous alloys as an effective method to obtain a nanocrystalline structure [5]. The similar phenomena were found in Fe–Zr–B amorphous alloys [6,7] and

Zr–Cu based metallic glasses [8]. Atoms in materials are known to be dynamically displaced by an electron knock-on effect under electron irradiation and the crystalline structure in some alloys would be destroyed resulting in amorphous state [9,10]. The electron irradiation induced crystallization of the amorphous phase is closely related to the atomic diffusion and the phase stability of crystalline precipitates against electron irradiation.

The amorphous state in $Zr_{66.7}Cu_{33.3}$ alloy was easily obtained by a melt-spinning method and Zr_2Cu phase with the b.c.t.-structure precipitates from the amorphous phase by annealing [8]. In this paper, effects of electron irradiation on the amorphous and the crystalline phases in $Zr_{66.7}Cu_{33.3}$ alloy, and their phase stability under electron irradiation were examined.

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Table of Contents Phase Stability During Irradiation 1981

1. Understanding the eBook Phase Stability During Irradiation 1981
 - The Rise of Digital Reading Phase Stability During Irradiation 1981
 - Advantages of eBooks Over Traditional Books
2. Identifying Phase Stability During Irradiation 1981
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Phase Stability During Irradiation 1981
 - User-Friendly Interface
4. Exploring eBook Recommendations from Phase Stability During Irradiation 1981
 - Personalized Recommendations
 - Phase Stability During Irradiation 1981 User Reviews and Ratings
 - Phase Stability During Irradiation 1981 and Bestseller Lists

5. Accessing Phase Stability During Irradiation 1981 Free and Paid eBooks
 - Phase Stability During Irradiation 1981 Public Domain eBooks
 - Phase Stability During Irradiation 1981 eBook Subscription Services
 - Phase Stability During Irradiation 1981 Budget-Friendly Options
6. Navigating Phase Stability During Irradiation 1981 eBook Formats
 - ePub, PDF, MOBI, and More
 - Phase Stability During Irradiation 1981 Compatibility with Devices
 - Phase Stability During Irradiation 1981 Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Phase Stability During Irradiation 1981
 - Highlighting and Note-Taking Phase Stability During Irradiation 1981
 - Interactive Elements Phase Stability During Irradiation 1981
8. Staying Engaged with Phase Stability During Irradiation 1981
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Phase Stability During Irradiation 1981
9. Balancing eBooks and Physical Books Phase Stability During Irradiation 1981
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Phase Stability During Irradiation 1981
10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
11. Cultivating a Reading Routine Phase Stability During Irradiation 1981
 - Setting Reading Goals Phase Stability During Irradiation 1981
 - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Phase Stability During Irradiation 1981
 - Fact-Checking eBook Content of Phase Stability During Irradiation 1981
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning

- Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
14. Embracing eBook Trends
- Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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