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# INVESTIGATION OF PLASTIC DEFORMATION OF METAL ALLOYS USING ACOUSTIC EMISSION SIGNALS

**Arabboyeva Maftuna Jasurbek kizi** [1]

e-mail: arabboyeva98@mail.ru

tel: +998978351898

[1] Master student of Feregana polytechnic institute

**Husanov Yunusali** [2] **-** head teacher.

[2] Teacher at Feregana polytechnic institute

**Abstract**:The investigation of plastic deformation in metal alloys using acoustic emission signals has emerged as a crucial area of study in materials science and engineering. This article explores the various aspects of utilizing acoustic emission signals to understand the behavior of metal alloys under stress and deformation. The research focuses on the significance of acoustic emissions, experimental methodologies, results, and discussions related to the plastic deformation of metal alloys.

**Keywords**:plastic deformation, metal alloys, acoustic emission, materials science, stress analysis.

**Annotatsiya**:Bu maqolada murakkab metall splavlari plastik rivajlanishining ovoz emissiya signalari orqali tadqiqoti mavzusiga keng tomoshada e'tibor qaratiladi. Mazkur sohada o`tkazilayotgan tadqiqotlar plastik rivajlanishning ovoz emissiya signalari yordamida hisobga olingan qismlari, nazorat, natijalar va muzokaralar bilan bog`liq bo'ladi.

## 1. Introduction

In recent years, the investigation of plastic deformation in metal alloys using acoustic emission signals has gained significant attention due to its potential in providing real-time monitoring of material behavior. This section provides an overview of the importance of understanding plastic deformation, the role of acoustic emission signals, and the significance of this research in materials science and engineering. The investigation of plastic deformation of metal alloys using acoustic emission signals represents a crucial area of study in material science and engineering. Acoustic emission (AE) signals provide valuable insights into the behavior of materials under mechanical stress, offering real-time monitoring and analysis capabilities. This research topic holds significant promise for understanding the intricate processes involved in plastic deformation, which is essential for various industries such as manufacturing, construction, and aerospace.

The use of acoustic emission signals to investigate plastic deformation in metal alloys has gained attention due to its potential in capturing the microstructural changes occurring within the material during deformation. By studying AE signals, researchers can gain a deeper understanding of the nature and progression of plastic deformation, leading to improved material design, structural integrity, and performance optimization.

In this context, the investigation of plastic deformation of metal alloys using acoustic emission signals is not only of academic interest, but also holds practical implications for enhancing the reliability and safety of metal components and structures. The ability to detect and interpret acoustic emission signals during deformation provides a window into the behavior of materials at

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the microscale, paving the way for advanced characterization techniques and predictive modeling.

This introduction sets the stage for delving into the methods, results, analysis, and implications of studying plastic deformation of metal alloys using acoustic emission signals, ultimately contributing to the advancement of materials science and engineering.

**2. Methods**

This section outlines the experimental procedures and methodologies employed to investigate plastic deformation using acoustic emission signals. It includes details about sample preparation, testing parameters, and the setup used to capture and analyze acoustic emission signals during deformation experiments.

The methodology for investigating plastic deformation of metal alloys using acoustic emission (AE) signals involves a systematic approach to conducting experiments, capturing AE signals, and analyzing the data obtained. The following steps outline a typical methodology for this investigation:

1. Sample Preparation:

- Selecting appropriate metal alloy specimens for the study, considering factors such as composition, microstructure, and intended deformation conditions.

- Preparing the samples with precise dimensions and surface finish to ensure consistency and repeatability in subsequent tests.

2. Experimental Setup:

- Designing and setting up the experimental apparatus to subject the metal alloy samples to controlled mechanical loading, such as tension, compression, or bending, depending on the deformation characteristics of interest.

- Integrating AE sensors strategically onto the sample or in the vicinity to capture signals emitted during deformation.

3. Data Acquisition:

- Implementing suitable data acquisition systems to capture AE signals in real-time during the deformation process.

- Ensuring synchronization between mechanical loading and AE signal acquisition to correlate the observed signals with the applied stress and strain levels.

4. Signal Processing and Analysis:

- Processing the raw AE signals to extract relevant features using signal processing techniques such as filtering, time-frequency analysis, and amplitude thresholding.

- Analyzing the characteristics of the AE signals, including event count, amplitude distribution, energy release, and waveform patterns to identify correlations with the stages of plastic deformation.

5. Correlation with Mechanical Tests:

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- Conducting concurrent mechanical tests to measure load-displacement behavior, stress/strain distribution, and other mechanical properties of the metal alloy samples.

- Establishing correlations between the AE signals and the mechanical response of the samples, linking specific AE features with distinct stages of plastic deformation such as yielding, work hardening, and necking.

6. Microstructural Analysis:

- Post-deformation, conducting microstructural analysis using techniques like optical microscopy, SEM, or TEM to study the evolution of defects, dislocations, and other internal changes within the material.

- Relating the observed microstructural features to the AE signals recorded during the deformation to gain insights into the underlying deformation mechanisms.

7. Statistical and Comparative Analysis:

- Performing statistical analysis to quantify AE activities and derive meaningful trends or patterns related to plastic deformation across different testing conditions or alloy types.

- Comparing the AE signatures from different alloy compositions, heat treatments, or processing conditions to identify unique characteristics associated with specific material properties or deformation behaviors.

By following this comprehensive methodology, researchers can gain a detailed understanding of the plastic deformation behavior of metal alloys using acoustic emission signals, leading to valuable insights for material characterization, performance assessment, and predictive modeling in various engineering applications.

## 3. Results

The results section presents the findings of the investigation, including the acoustic emission signals recorded during the plastic deformation of various metal alloys. This may involve graphical representations of the signals, analysis of their characteristics, and the correlation between acoustic emissions and the extent of plastic deformation.

## 4. Analysis and Discussion

The analysis and discussion focus on interpreting the results obtained from the acoustic emission signals. This section explores the relationship between the signals and the underlying microscopic processes that occur during plastic deformation. Furthermore, it discusses the implications of the findings and potential applications in materials science, engineering, and structural health monitoring.

## 5. Conclusion

The conclusion encapsulates the key findings of the investigation, emphasizing the significance of acoustic emission signals in understanding plastic deformation behaviors in metal alloys. It also addresses any limitations encountered during the study and provides recommendations for future research directions in this field.

In conclusion, the investigation of plastic deformation in metal alloys using acoustic emission signals represents a vital area of research in materials science and engineering. Understanding the behavior of metal alloys under stress and deformation is crucial for various industrial

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applications, and the utilization of acoustic emission signals offers promising insights into real-time monitoring and analysis of material performance.

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