EFFECT OF STRAIN HARDENING PARAMETERS ON DEFORMATION INDUCED ELECTROMAGNETIC RADIATION FROM METALS AND ALLOYS

A Thesis

Submitted

By

ANMOL KOTHARI (S12023)

For the award of degree of

Master of Science (*by research*)

SCHOOL OF ENGINEERING

INDIAN INSTITUTE OF TECHNOLOGY MANDI

Mandi, Himachal Pradesh -175001

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Declaration by the Research Scholar

This is to certify that the thesis titled "**Effect of strain hardening parameters on deformation induced electromagnetic radiation from metals and alloys**" submitted by me, to the Indian Institute of Technology Mandi for the award of the degree of **Master of Science (Research)**, is a bona fide record of the research work carried out by me in the School of Engineering, Indian Institute of Technology Mandi, under the supervision of Dr. Vishal Singh Chauhan and Dr. Rajeev Kumar. The contents of this thesis, in full or in parts, have not been submitted to any other Institute or University for the award of any degree or diploma.

In keeping with the general practice of reporting scientific observation, due acknowledgements have been made wherever the work described is based on the findings of other investigators.

I.I.T. Mandi (H.P.) Anmol Kothari

Date: July 20, 2015

Indian Institute of Technology, Mandi
Mandi, Himachal Pradesh - 175005

भारतीय प्रौद्योगिकी संस्थान, मण्डी
मण्डी, हिमाचल प्रदेश - 175005

Thesis Certificate

This is to certify that the thesis titled "**Effect of strain hardening parameters on deformation induced electromagnetic radiation from metals and alloys**" submitted by **Anmol Kothari**, to the Indian Institute of Technology Mandi for the award of the degree of **Master of Science (Research)**, is a bona fide record of the research work done by him under our supervision in the School of Engineering, Indian Institute of Technology Mandi. The contents of this thesis, in full or in parts, have not been submitted to any other Institute or University for the award of any degree or diploma.

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Dr. Vishal Singh Chauhan
Assistant Professor
School of Engineering
IIT Mandi

Date: July 20, 2015

Dr. Rajeev Kumar
Assistant Professor
School of Engineering
IIT Mandi

Date: July 20, 2015

ABSTRACT

The demand of developing highly efficient mechanical and aerospace systems has led to advancement in various fields such as structural dynamics and control, fracture mechanics and mechanics of materials. The focus is to develop the technology through which early detection of any failure can be determined and contained. In this regard, it is highly imperative to strengthen the fundamentals of physics and mechanics of deformation and fracture.

Investigation of effects associated with plastic deformation, micro-crack formation and propagation and fracture have been aided by progressive growth in instrumentation technology. Effectively researchers world-wide have detected and studied various types of emissions such as thermal, acoustic, ions, exo-emissions etc. which occurs when a solid material is subjected to high stresses. As a consequence, the emission of electromagnetic radiation (EMR) during the crack propagation and fracture in metals was first reported by Misra (1975a). Misra (1978) further reported that metals and alloys also emit EMR during yielding and at intermittent stages of strain hardening, in addition to crack propagation and fracture.

A theoretical model is developed to analyze and predict the electromagnetic radiation (EMR) during the strain hardening of metals and alloys. Initial investigations were done by neglecting the role of Peierls stress on dislocation dynamics. The results predicted by the model have been compared with the experimental results on the ASTM B265 grade 2 Titanium. Further a second

model is developed which explicitly embraces the effect of Peierls stress and strain hardening to envisage the EMR phenomenon. The theoretical results were evaluated for 0.15% plain carbon steel and compared with experimental results. The results suggest that inclusion of Peierls stress and strain hardening is quite significant in determining deformation induced EMR in metals and alloys during progressive plastic deformation. The model confirms the observation that the amplitude of oscillatory EMR is generally much larger than the amplitude of exponential EMR. The model also suggests that the viscous damping offered by the material to the dislocation motion undergoes variation during progressive plastic deformation and this variation has dependence on the strain hardening exponent.

Keywords: Electromagnetic radiation, Plastic deformation, Strain hardening, Dislocation

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