

**Sudan University of Science and Technology**  
College of Graduate Studies

# **Surface Hardening of Carbon Steels by High power CO<sub>2</sub> Laser**

Thesis Submitted for the Partial Fulfillment for Requirements of Master  
Degree in Laser Applications in Mechanical Engineering

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بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِیْمِ

وَمَا أُوتِیْتُمْ مِنْ ... ( )  
( الْعِلْمِ إِلَّا قَلِیْلًا )

(الإسراء الآیة 85)

# DEDICATION

*I dedicate this work to...*

*My parents...*

*My wife ...*

*My teachers...*

*And to all those I love*

# ACKNOWLEDGEMENT

*Praise be to **Allah** and his bless and peaceful be to **Prophet of Allah**.*

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# ABSTRACT

In this work surface hardening treatment of carbon steel specimens, that having a carbon contents ranging between 0.25 and 2.44%, was done using CO<sub>2</sub> laser having 10.6 $\mu$ m wavelength, 100 $\mu$ m spot size and with powers ranged between 100-300 W.

The dependence of the surface hardness on laser power (laser intensity), scanning speed (exposure time), specimen carbon content and specimen thickness were performed. It was shown that the enhancement in target surface hardness increased with laser power and decreased, with increasing the scanning speed for fixed power. Also it was found that, the enhancement in target surface hardness was increased with the increasing in carbon percentage and decreased when the target was thicker.

High power laser hardening technique proves the possibility of controllable hardness enhancement via controlling the laser interaction parameters.

## الخلاصة

في هذا البحث تم إجراء عملية التصليد السطحي لعينات من الفولاذ الكربوني يتراوح محتوى الكربون فيها بين 0.25% و 2.44%، باستخدام ليزر ثنائي أكسيد الكربون طول الموجي 10.6 مايكرومتر وحجم بقعة الليزر حوالي 100 مايكرومتر وبقدرة تراوحت بين 100-300 واط .

اختبرت العلاقة بين الصلادة السطحية وكل من قدرة الليزر، سرعة عملية التشعيع ، محتوى الكربون بالعينة وسماكة العينة. و قد ثبت أن مقدار التحسن في تصليد السطح يزيد بزيادة قدرة الليزر ويقل، بثبوت القدرة، بزيادة سرعة عملية التشعيع. كذلك وجد أن مقدار التحسن في صلادة السطح يزيد بزيادة محتوى الكربون بالعينة ويقل مع زيادة سماكة العينة المعالجة.

إن تقانة زيادة الصلادة باستخدام ليزر ثنائي أكسيد الكربون عالي القدرة أثبتت إمكانية زيادة الصلادة بطريقة متحكم فيها من خلال السيطرة على عوامل عملية تفاعل الليزر مع العينات.

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