University of technology
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LASER APPLICATION COURSE
4TH YEAR
LEC.1

Chapter One General Introduction

- Laser technology is one of the most rapidly developing areas in modern technology, when the laser was invented in 1960, it was classified as ***Solution in search of a problem***, and today laser technology is applied in many different areas. The number of applications of laser is enormous, and it is not possible to explain all of them her. In this course, the laser applications are divided into four groups as shown as below
- 1. Industrial Applications. التطبيقات الصناعية
- 2. Metrological & Scientific Applications. التطبيقات العلمية والقياسات
  3. Medical Applications. التطبيقات الطبية
  4. Military Applications. التطبيقات العسكرية
- *But at first we explain by details the **material** & **laser** parameters that effected on the laser applications. And our hope is that with time we will fill the missing information on most of the well known applications of lasers.*

MATERIAL & LASER PARAMETERS

- Material & Laser Parameters that affect laser processing are discussed in this section[2].
- ***1.2.1. Material Parameters***
- ***1. Reflectance (R):*** Is the ratio of the power reflected from a surface to the power incident on it[2].

$$R = \left(\frac{n_1 - n_2}{n_1 + n_2}\right)^2 \qquad \textbf{\textit{...(1.1)}}$$

Where: n_1 & n_2 are the refractive index of the substrate material and incident medium, respectively. The amount of light that absorbed by the metal equal to **(1-R)%** .

- Metals like copper & silver have high reflectance's that increase with wavelength and, it is found that the reflectance of metals decreases as the temperature nears the melting point.
- ***2. Absorption Coefficient (α):*** Is the fractional loss of light power per unit distance for light traveling in a nonmetallic material. Beer's (Lambert's) law relates power to absorption by[2]:

$$P = P_o e^{-\alpha Z} \qquad \textbf{...(1.2)}$$

Where:

P: is the power at depth (Z), P_o: is the power entering the surface.

- ***3. Heat Capacity & Specific Heat***
- ***a- Heat Capacity (c):*** Is the amount of energy needed to rise the temperature of unit mass (sample) one Celsius degree (1°C). From this definition, we see that if energy ***Q*** produces a change **ΔT** in the temperature of a sample, then[3]:
- $$Q = c\,\Delta T \qquad ..(1.3)$$
- ***b- Specific Heat (C)***: Is the heat capacity per unit mass. Thus, if energy **Q** transfers to a sample change by ***ΔT,*** then the specific heat of the sample is [3]:
- $$C \equiv \frac{Q}{m\Delta T} \qquad (J/kg.^{o}C) \qquad ...(1.4)$$

- ***4. Thermal Conductivity (K):*** Is the heat flow per unit area per unit thermal gradient. And indicates to the units for ***K*** are (W/cm.C^o)[2].
- ***5. Thermal Diffusivity (k):*** is a measured of how much temperature rise will be caused by a pulse of heat applied to the material. Units are generally (cm^2/s). By using the laser, material melting depended on thermal flow of it. And this flow had a directly relation with thermal conductivity (K), and reversely with Specific Heat (C) and density of the material **k = K/ρC**. [2].

- ***6. Latent Heat (L):***Refers to the amount of heat required to cause a change of phase of unit mass of material. _Because this added or removed energy dose not result in a temperature change, the quantity **L** is called **latent heat**[3]**.**_
- ***L_m:*** Is the Latent heat of fusion or the energy required to case melting of unit mass (J/kg).
- ***L_V:*** Is the latent heat of vaporization and has the same meaning and units as L_m. ***Latent heat of vaporization are much large than Latent heat of fusion.***
- ***7. Transformation Temperature (T):*** Refers to the melting temperature (T_m), Vaporization temperature (T_V) & other phase change temperature (T_P)[2].