Tampere University of Technology
Institute of Materials Science

MOL-3116 Introduction to NDT techniques

Examination 2.5.2011

NO LITERATURE IS ALLOWED, RESETED CALCULATORS ALLOWED, DICTIONARIES ALLOWED

ANSWER TO 5 QUESTIONS ONLY! / Vastaa viiteen kysymykseen!

ANSWER EVERY QUESTION TO SEPARATE ANSWER PAPER!
/vastaa jokainen kysymys omalle konseptipaperille!

1. Explain briefly:
   a) subject contrast
   b) geometric unsharpness
   c) optical holography
   d) radiation dose
   e) inductive reactance
   f) Barkhausen noise
   g) Kaiser effect
   h) permeability
   i) phased array sensor
   j) indirect magnetization

2. The principle of eddy current inspection and the most important factors affecting the inspection depth?

3. Visual inspection, advantages and disadvantages and applications?

4. What different NDT methods can be used to inspect material flaws located in the interior of the material?

5. IR thermography

6. Compare liquid penetrant inspection and magnetic particle inspection; the usage of the methods, differences, limitations and applicability to detect different discontinuities

Equations

$1 / d^2 = (h^2 + k^2 + l^2) / a^2$

$E = h \nu = h (c/\lambda)$

$\lambda L = R d_{hkl}$

$\mathbf{P} / \lambda = h \mathbf{a}^* + k \mathbf{b}^* + l \mathbf{c}^*$

$n \lambda = 2 d \sin\theta$

$\cos\varphi = (h_1h_2 + k_1k_2 + l_1l_2) / [(h_1^2 + k_1^2 + l_1^2)^{1/2} (h_2^2 + k_2^2 + l_2^2)^{1/2}]$

$DF = \varepsilon / \tan\alpha \approx \varepsilon / \alpha = d_{CRT} / (\alpha M)$

$1 / \lambda = k (Z - \sigma)^{1/2}$

$I / I_o = \exp [-(\mu/\rho) (\rho x)]$

$\delta = 0.61 \lambda / (\mu \sin\alpha)$

$d = \delta / \tan\alpha$

$D = M^2 d$

$C_i = (ZAF)_i (I_i / I_{(i)})$

$E_o / E_{ic} = U$

$\lambda = h \nu = 1.2398 / E$ [nm] ; E in [kV]

$$f_\theta = \left[\left(me^2\right)/\left(2h^2\right)\right]\left[\lambda / \left(\sin\theta\right)\right]^2 \left(Z - f_x\right)$$

$$F_{hkl} = \sum_n f_n \exp\left\{2\pi i \left(hx_1 + ky_1 + lz_1\right)\right\}$$

$$\left|F\right|^2 = \sum_i f_i \cos\left\{2\pi i \left(hx_1 + ky_1 + lz_1\right)\right\} + \sum_i f_i \sin\left\{2\pi i \left(hx_1 + ky_1 + lz_1\right)\right\}$$

Structure	Reflection absent if
Simple cubic	All present
fcc	h, k, l, mixed odd and even
bcc	h+k+l odd
hcp	h+2k = 3n and l is odd

$$B = \mu H$$

$$X_L = \omega L = 2\pi f L$$

$$Z = \sqrt{\left(R^2 + X^2\right)}$$

$$J_x = J_o \exp(-x/\delta)$$

$$\delta = \left(\pi f \mu \sigma\right)^{-1/2}$$

$$\nu = \mathrm{v}\,\lambda$$

$$\sin\alpha_i / \sin\beta_r = \mathrm{v}_i / \mathrm{v}_r$$

$Z_L = \rho V_L$: unit for ρ is g/cm^3 , and for V_L cm/μs

$$R = \mathrm{I}_r / \mathrm{I}_i = \left[\left(Z_2 - Z_1\right)/\left(Z_2 + Z_1\right)\right]^2 \qquad T = \mathrm{I}_t / \mathrm{I}_i = 4 Z_1 Z_2 / \left(Z_1 + Z_2\right)^2$$