http://dx.doi.org/10.21611/qirt.2014.087

A model for the depth effect on the reconstruction of defect geometry triangular by pulsed thermography

by A.Elhassnaoui [*], S. Sahnoun [*]

[*] Laboratory of Electronics, Instrumentation and Signal Processing, Faculty of Sciences, B.P 20. 24000 El Jadida, - Morocco. *ssahnoun@gmail.com*

Abstract

The purpose of this work is to reconstruct the triangular shape of a defect on the rear inaccessible face of PVC sample . Reconstruction is to evaluate, in each point of the accessible surface heated by a heat pulse, the thickness of the sample from the distribution of surface temperature. In this paper, for a defect of triangular geometry which has a given opening angle, we will study the effect of its depth on the reconstruction of its geometric shape ; then we propose a model based on finite element which allow to rebuild its triangular shape taking account of its depth.

Keywords: pulsed thermography, defect geometry, triangular defect, opening angle.

In this paper, we investigate the effect of the depth of the defect on the reconstruction of the triangular shape defect. We present an improvement of AEM model developed by the authors [1] by proposing a correction for reconstruct the shape of a triangular geometric defect taking into account the depth of the defect.

I. Effect of depth on the reconstruction of the geometric shape of a triangular defect

1 Calculating relative temperature $T_{rel}(t)$ by the method of finite elements

Consider samples of the same dimensions (x = 0.15 m, y = 0.02 m et z = 0.15 m), and having an inaccessible defect that have a triangular shape with an opening angle α=90°(figures 1). The depth of the defect varies from sample to sample from 5.10^{-4}m to 4.10^{-3}m.

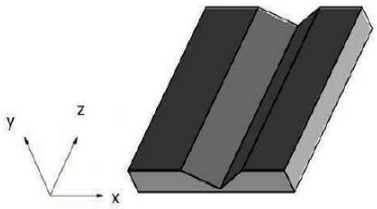

***Fig.1**: Sample of PVC in 3D. The default is represented by a triangular shaped notch*

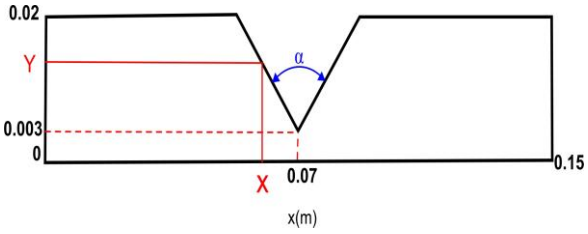

***Fig.2**: Sample of PVC in 2D, α=90°.*

The material of our samples is untreated surface of black and hard PVC, with an absorption coefficient equal to 0.96.

2 Results

Figure 3 shows for each value of the defect depth, the thickness variation y (Figure 2) as a function of relative temperature T_{rel} taken at t=60s after heating

We note that the variation of the thickness y depending on the relative temperature T_{rel} depends on the defect depth.

II. Model for the reconstruction of the triangular shape fault taking into account the effect of the depth

The proposed model is an improved of model AEM [1] to include the effect of the depth defect p on the estimation of the thickness y from the relative temperature at each point on the accessible surface. It is written as follows:

http://dx.doi.org/10.21611/qirt.2014.087

$$y = A(\alpha, p)[-\frac{kt}{\rho c}\ln(T_{rel}(t))]^{\frac{1}{2}} - B(\alpha, p)T_{rel}(t)^{C(\alpha,p)} + D(\alpha, p) \qquad (2)$$

with:

- y: thickness of the sample meter;
- t: time elapsed after the heating pulse in seconds;
- k: thermal conductivity in watts per meter-Kelvin;
- ρ: density in kilograms per cubic meter;
- c: specific heat capacity in joules per kilogram Kelvin;
- $T_{rel}(t)$: the relative temperature given by equation (1);
- α: the opening of the triangular angle in radians;
- p: flaw depth in meters;

A coefficients (α, p), B (α, p), C (α, p) and D (p) are polynomials.

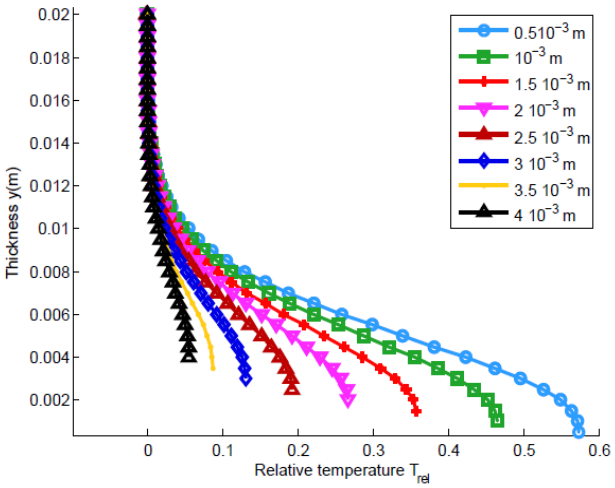

***Fig.3**: Variation of thickness y according to T_{rel} for different values of the defect depth (510^{-4}m to 410^{-3}m), α = 90 °*

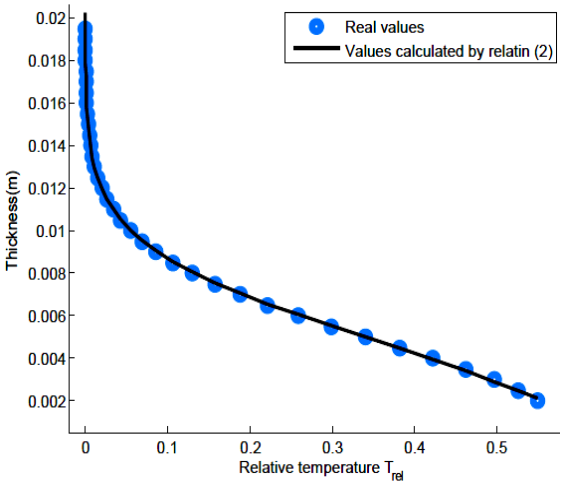

***Fig. 4** Case of a defect located at a depth p = 5.10^{-4}m.*

Figure 4 superimposes the real and the calculated thickness by the proposed model in the relationship (2) in the case of a defect located at a depth p = 5.10^{-4}m.

III. Conclusion

We have developed a model for the reconstruction of the triangular shape of defect from pulsed thermography data. Indeed, we considered the case of a PVC sample with a triangular defect on the inaccessible face and we applied a heat flux during a short time on the accessible face. We studied the effect of defects depth on the estimation of the thickness from the relative temperature of heated face. We found that the variation in the defect depth affects the determination of the thickness depending on the temperature. To take account of the depth reconstruction of the defects shape we have proposed a model that integrates the defect depth in the calculating of the sample thickness from the relative temperature. The values of the differences between the actual thickness and those calculated by the proposed model in this paper remain low for triangular defect at a depth ranging from 5.10 $^{-4}$ m to. 4.10 $^{-3}$ m.

*R*eferences

[1] A. Elhassnaoui, A. Elballouti and S. Sahnoun, "Reconstruction of a triangular geometry defects in inaccessible face by a model of active thermography" J. Optoelectron. Adv. Mater. 15, 5-6, 447 - 450 (2013).

[2] H.D. Benitez, C. Ibarra-Castanedo, A.H. Bendada, X. Maldague, H. Loaiza, E. Caicedo, Definition of a new thermal contrast and pulse correction for defect quantification in pulsed thermography, Infrared Phys. Technol. 51 (2008) 160–167.