Measuring the in-plane thermal diffusivity by photothermal spatially random pattern

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A laser pulse, with duration 2 ms, and characterized by a random spatial distribution in a square area of 1 by 1 cm, is projected on the surface of a specimen. An IR camera collects a sequence of images of the specimen's surface temperature. Those images are quite sharp immediately after the pulse, resembling the light pattern randomly distributed that was projected (see Fig. 1). As the time goes by, the pattern decreases in intensity and blurs as well, due to the diffusion of heat. The components of the spatial Fourier Transform of the temperature field, collected by the IR camera, are analysed in time. Their amplitudes are decreasing with time according to an exponential decreasing function. The time constants depend on the spatial frequencies and on the thermal diffusivity of the specimen as well. Fitting the data allows finally to estimate the time constant and therefore, once the spatial frequency is known, the thermal diffusivity. Other spatial distributions, like the point, the line, and the periodic grid, were proposed in the past [1], while the random spatial distribution was considered but with a different data analysis [2]. In this study, because of the randomness of the pattern, several spatial frequencies are stimulated and can be analysed. That make the estimation of thermal diffusivity more robust. Eight random patterns have been prepared by gold spattering on glass substrate, in the facilities of Tokyo Tech Laboratory. Preliminary results are given in Tab.1, for a specimen of clay brick.

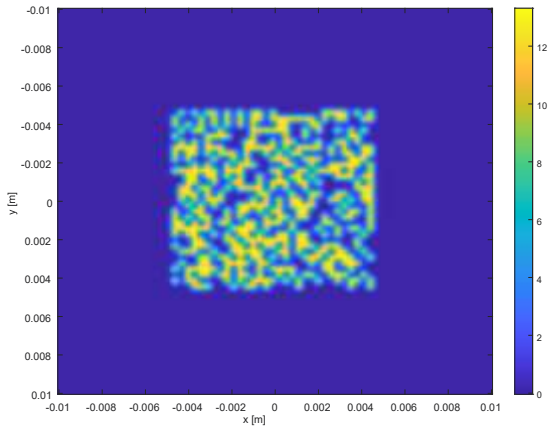

Fig. 1. Surface temperature immediately after the laser pulse with random spatial distribution.

Table 1. Thermal diffusivity results obtained by using 8 different random patterns projected on a specimen of clay brick.

	Pattern #1	Pattern #2	Pattern #3	Pattern #4	Pattern #5	Pattern #6	Pattern #7	Pattern #8
Thermal Diffusivity [m^2s^{-1}]	6.19E-07	6.20E-07	6.35E-07	6.27E-07	6.28E-07	6.57E-07	6.23E-07	6.27E-07
Standard deviation [m^2s^{-1}]	4.89E-09	1.06E-08	2.30E-09	7.29E-09	4.30E-09	5.73E-09	5.35E-09	1.76E-08

Significant references

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2. J.C. Batsale, J.L. Battaglia, O. Fudym, *Quantitative InfraRed Thermography Journal*, 1:1, 5-20, (2004), DOI: 10.3166/qirt.1.5-20.