Terahertz guided time domain reflectometry simulation for several waveguides and electronics packages

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Terahertz guided time domain reflectometry is a well-known technique allowing open circuit detection and localization in waveguides or 3D packages interconnections. It can be used to detect through silicon via (TSV) delamination [1], characterize open in solder bumps [2] and locate an open in a daisy chain [3] or a crack in a layer of an integrated circuit [4]. We used electromagnetic finite-difference time-domain method to simulate propagation and reflexion of terahertz pulse in several components in order to evaluate order of magnitude of the signal that we can expect. We applied this method to millimeter-wave frequencies typical waveguides like coplanar, microstrip and single wire. We obtained in Fig 1 a signal reflected with a delay depending on the position of the defect. Then we applied this method to localization of open circuit in a BGA (ball grid array) package, a TSV and a daisy chain. We can see in Fig 1(d) and (e) that signal reflected depend on the connection between a BGA ball and the TSV.

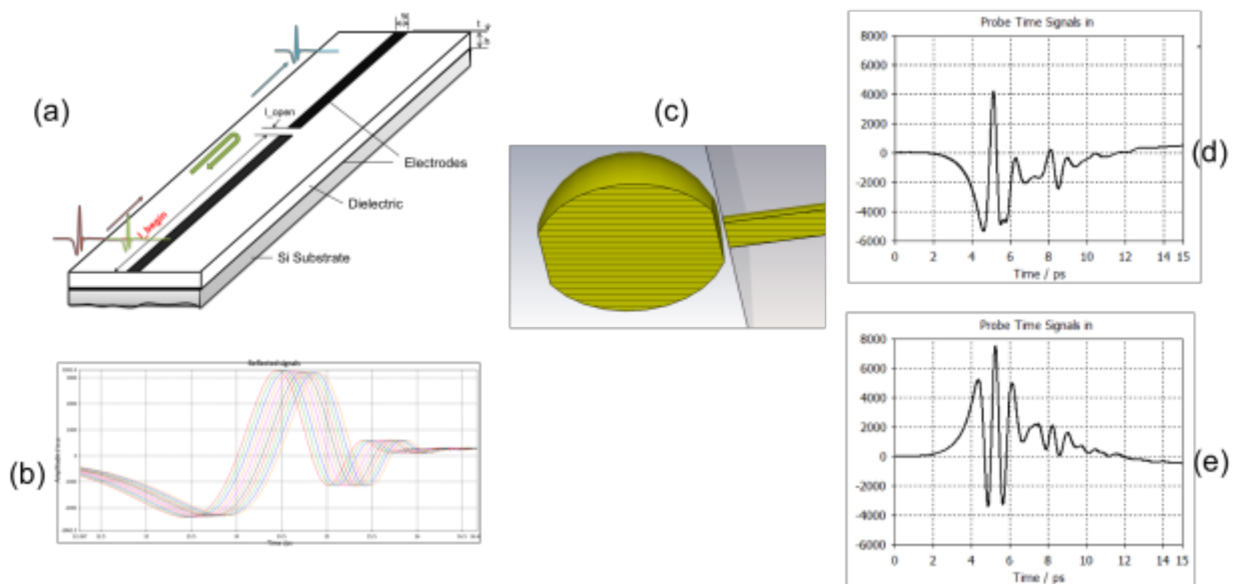

Fig.1. (a) Waveguide with a defect (b) Signal reflection depending on the positon of defect (c) Open between a BGA ball and a via (d) Signal reflected with open(e)Signal reflected when correctly connected

References :

[1] E. Kowalczuk, A. Bhattacharya, K. C. Lee, J. Alton, M. Igarashi, et S. Barbeau, « Fault Localisation of defects using ElectroOptical Terahertz Pulse Reflectometry and 3D EM modelling with Virtual Known Good Device », *Proc. IEEE 3D Syst. Integr. Conf. 2014*, p. 14, 2014.
[2] D. P. Vallett, D. A. Bader, V. V Talanov, J. Gaudestad, N. Gagliolo, et A. Orozco, « Localization of dead open in a solder bump by space domain reflectometry », in *Proc Int Symp Lest, Fail Anal (ISLFA)*, 2012, p. 1720.
[3] A. Reverdy, M. Marchetti, A. Fudoli, A. Pagani, V. Goubier, M. Cason, J. Alton, M. Igarashi, et G. Gibbons, « Electro Optical Terahertz Pulse Reflectometry, a non destructive technique to localize defects on various type of package », *Microelectron. Reliab.*, vol. 54, nº 910, p. 20752080, 2014.
[4] J. Alton et M. Igarashi, « Non-destructive fault localization in advanced IC packages using electro optical terahertz pulse reflectometry », *Microelectron. Packag. Conf. , 2013 Eur.*, p. 14, 2013.