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Virtual Metrology for Copper Clad Laminate Manufacturing

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Abstract : In semiconductor manufacturing, virtual metrology (VM) refers to methods to predict properties of a wafer based on machine parameters and sensor data of the production equipment, without performing the (costly) physical measurement of the wafer properties (Wikipedia). Additional benefits include avoidance of human bias and identification of important factors affecting the quality of the process which allow improving the process quality in the future. It is however rare to find VM applied to other areas of manufacturing. In this work, we propose to use VM to copper clad laminate (CCL) manufacturing. CCL is a core element of a printed circuit board (PCB) which is used in smartphones, tablets, digital cameras, and laptop computers. The manufacturing of CCL consists of three processes: Treating, lay-up, and pressing. Treating, the most important process among the three, puts resin on glass cloth, heat up in a drying oven, then produces prepreg for lay-up process. In this process, three important quality factors are inspected: Treated weight (T/W), Minimum Viscosity (M/V), and Gel Time (G/T). They are manually inspected, incurring heavy cost in terms of time and money, which makes it a good candidate for VM application. We developed prediction models of the three quality factors T/W, M/V, and G/T, respectively, with process variables, raw material, and environment variables. The actual process data was obtained from a CCL manufacturer. A variety of variable selection methods and learning algorithms were employed to find the best prediction model. We obtained prediction models of M/V and G/T with a high enough accuracy. They also provided us with information on “important” predictor variables, some of which the process engineers had been already aware and the rest of which they had not. They were quite excited to find new insights that the model revealed and set out to do further analysis on them to gain process control implications. T/W did not turn out to be possible to predict with a reasonable accuracy with given factors. The very fact indicates that the factors currently monitored may not affect T/W, thus an effort has to be made to find other factors which are not currently monitored in order to understand the process better and improve the quality of it. In conclusion, VM application to CCL’s treating process was quite successful. The newly built quality prediction model allowed one to reduce the cost associated with actual metrology as well as reveal some insights on the factors affecting the important quality factors and on the level of our less than perfect understanding of the treating process.

Keywords : copper clad laminate, predictive modeling, quality control, virtual metrology
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