Iteration Convergence of XRF Thickness Measurement Using Coating Substrate as Internal Standard

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XRF thickness and composition measurement is widely used in production quality control of fastener and automotive parts. Attributable to irregular shape of the parts, industries often take XRF measurement at long focal distance to avoid potential damage of XRF measurement head.

Measuring at long focal distance can cause some measurement errors. For instance, most XRF instruments of thickness measurement use laser triangulation to tell the distance from parts to XRF measurement head so to validate consistency of detection and emission solid angles. With longer focal distance, Laser projection angle became steeper, the center of laser spot is less sensitive to focal distance change. Therefore, variations in focal distance can sometimes be as much as +/-0.5 mm when measuring at long focal distance. XRF intensity approximately related to focal distance by 4th power of the inverse. Variations in focal distance can significantly affect accuracies of XRF thickness measurement.

One method of correcting variations in focal distance is using coating substrate as an internal standard, sometimes refer to as internal standard ratio method. In this case, XRF intensity of a coating layer (or layers) is ratioed to the intensity of bulk substrate. There are two reasons for using intensity ratio. The first is that with coating substrate as an internal standard, focal-distance variation caused by uncertainty in laser focus can be partially or near completely canceled out. The second reason is that with internal standard ratio method, the depth resolution can be increased.

However, when using ratio method in XRF thickness measurement, iteration of thickness calculation in fundamental parameters algorithm needs to be modified, otherwise, iteration could either diverge or converge to wrong values. Speed of convergence can also be important. With this presentation, iteration algorithm of ratio method is discussed. A new iteration algorithm has been constructed and tested. Results on some automotive parts measurements will be presented.