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Core temperature measurement of metals using ultrasound during on-CMM inspection

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Abstract
During On-CMM inspection of parts, previous processes may cause the surface temperature of the part to differ significantly from its core temperature. This is especially true for large workpieces. This variation can affect the accuracy of measurement, this is because temperature compensation on CMMs is done using the values obtained from the conventional on-CMM temperature probe which only measures the surface temperature. The velocity of sound waves such as ultrasound traveling through a material is affected by the average temperature of that material. Hence, if the time and distance of travel are known, the ultrasonic velocity and consequently the average temperature of the medium can be estimated. One of the main limitations of ultrasonic thermometry for precision measurements is the associated cost of the required electronics. To overcome this, a novel ultrasonic phase-shift thermometry system was created. This was used for core temperature measurement during on-CMM inspection. The results show that the ultrasonic system predicts material expansion with a higher accuracy than the on-CMM temperature probe. The error from the predicted expansion based upon the surface temperature when compared to actual expansion measured is 1.1 µm while the error from the ultrasonic system is 0.58 µm.

Core temperature, manufacturing, phase-shift, ultrasound.