Ultra-precision cutting on thin-walled cylinder with deformation estimation and compensation method

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Thin-walled components have the characteristics of high strength and lightweight, so they are widely used in aviation, automobile and other industrial fields. However, the low stiffness of thin-walled workpieces causes them to be deformed by cutting forces during processing, which will seriously affect the surface morphology of the processed workpieces. To increase the processed surface dimensional accuracy, this paper proposed a deformation estimation and compensation method. Through finite element simulation, the axial deformation curve of the thin-walled cylinder was obtained, and experiments were carried out to verify it. Three capacitive displacement sensors are arranged on the same axis away from the cutting point. Based on the axial deformation curve, the deformation of the cutting point can be accurately estimated. The estimated deformation is then fed back to the fast tool servo, which can compensate for the deformation effectively. The cutting experiments were conducted, and a double sinusoidal microstructure was machined on the thin-walled cylindrical surface. The results showed that the circumferential morphology error and axial morphology error of the microstructure were highly reduced.

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