A Composite Air Spindle-Rotor System

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ABSTRACT

If the spindle shaft of an air spindle system is made of high stiffness carbon fiber composite material, the spindle system will be dynamically robust because the maximum rotating speed of a spindle (or rotor) system is usually restricted by the critical whirling vibration frequency of spindle shaft which is proportional to $(EI/m)^{0.5}$ (E : Young's modulus, I : flexural stiffness of shaft section, and m : mass of spindle per unit length). In this paper, the composite air spindle system composed of a high modulus carbon fiber composite shaft, powder contained epoxy composite squirrel cage rotor and aluminum tool holder was designed and manufactured. For the optimal design of the composite air spindle system, the stacking sequence and thickness of the composite shaft were selected by considering the fundamental natural frequency and deformation of the system. The analysis gave results that the composite air spindle system had 36 % higher natural frequency relative to a conventional air spindle system. The dynamic characteristics of the composite spindle system were compared with those of a conventional steel air spindle system. From the test result, it was found that the dynamic characteristics of the spindle system was enhanced by introducing composite materials thanks to the low inertia and high specific stiffness of the composite materials.

Keywords : Carbon fiber composite material, Air spindle, Composite squirrel cage rotor, Natural frequency, Damping characteristics

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