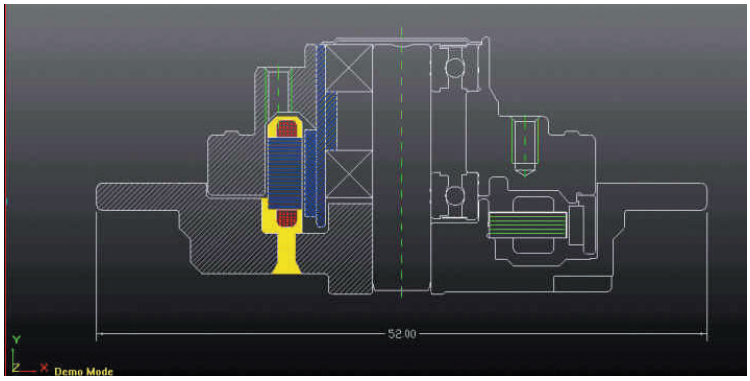

Encapsulation Yields Revolutionary Spindle Motor Design

For years, spindle motors for computer hard disk drives (HDDs) have been manufactured in a similar manner. Baseplates are fashioned from precision-machined aluminum, with the stator, terminations, and other components adhesive bonded together. These hard drive motors have faced the continual challenge of becoming smaller, faster, and more precise, while enduring relentless cost pressure. A rule-of-thumb in the industry is that data can be put on an HDD approximately four times more densely than that data can be read. For this reason, a primary industry focus is driving reductions in vibration and acoustic noise. Encap envisioned a pathway to utilize thermoplastic encapsulation to resolve many of these challenges facing HDD motors. To prove out this approach, a major hard drive manufacturer retained Encap to design and develop an encapsulated spindle motor for its product line.

Traditionally, the stator is slipped over a precision-machined aluminum baseplate, with the stator bonded to the baseplate. Encap approached the design by using a thermoplastic to encapsulate the wound stator and baseplate, in effect unitizing the structure. Overall size was reduced opening up more room for bearings and other components. This unitization of the motor also eliminates the need for a number of critical machined surfaces and eliminates associated stack-up tolerances. A proprietary method to locate the stator enabled concentricity better than that achievable using the existing manufacturing methods.

Any difference in CTE (coefficient of thermal expansion) between the plastic and encapsulated components causes a series of issues. When a CLTE differential exists between the case and mounting material, the stress level will change with temperature. Bearing performance can be significantly affected by raceway stress, leading to issues of RRO and NRRO (repeatable and non repeatable run out, respectively) in the spindle. Furthermore, pre-loads used to reduce run-out will be altered as materials expand at differential rates. When mounting the spindle motor to an aluminum drive body, the need to match rates for dimension consistency with respect to the head stack is also important.

To address all these issues, a new, ceramic reinforced resin was developed to enable matching of the plastic CTE with that of aluminum. The resin was also thermally conductive, which enabled the design of a thermal pathway to remove heat from the wound stator and the bearings.

Additionally, Encap incorporated a steel ferrule, which not only acted as the flux return path, but also the mounting interface between the bearings and the rotor. This greatly stiffened the motor, leading to a lower amplitude and higher frequency of resonance. The result of the complete motor redesign was a unit that exceeded best-in-class standards for noise and vibration.

Benefits:

- Vibration / acoustic noise reduction
- Component integration
- Cost reduction
- Reduction in NRRO (non repeatable runout)
- Thermal rise reduction
- Reduced offgassing

Encap Technologies, Inc.
707 S. Vermont St.
Palatine, IL 60067
(510) 337-2700
www.encaptech.com