

BEARINGLESS CENTRIFUGAL PUMP FOR HIGHLY PURE CHEMICALS

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ABSTRACT

In the semiconductor device manufacturing there are processes like etching, stripping, cleaning and polishing involving aggressive liquid chemicals. In these wet processes pumps are probably the most critical parts concerning the high requirements on purity, chemical resistance and reliability. The pump has to be a self-contained system to prevent any contamination of the highly pure liquids. Until today only pneumatically driven bellows or diaphragm pumps can fulfill these requirements. But this technology has some serious disadvantages.

A new bearingless pump system is introduced, which consists of a bearingless slice motor, a chemically resistant centrifugal pump and controller electronics. In a bearingless slice motor three spatial degrees of freedom can be stabilized passively. That reduces the complexity of the pump system. The slice-rotor levitates inside a hermetically closed pump housing. In order to prevent contamination of the liquids the slice-rotor is encapsulated with multiple polymer layers. Nevertheless, the permeation of aggressive chemicals through these polymer coatings has to be taken into account.

The benefits of a bearingless solution for a highly pure process pump are: As a rotary pump principle is applied, flow and pressure are continuous and can precisely be controlled. Absolutely no particles are generated inside the pump due to the contact-free bearing and the pump housing can be sealed hermetically. No maintenance is necessary because of the lack of mechanical wear. Compared to pneumatical solutions the pump system is small in size because of better efficiency.

MOTIVATION

As the density of transistors on the most powerful processors grows – now surpassing 200 million on a 1-cm² die – [1] the requirements for a clean environment raises. This also has to be considered for the chemicals used in wet processes, like etching, stripping or cleaning. In delivery and recirculation facilities pumps are probably the most critical parts referring to the high requirements on purity, chemical resistance and reliability.

Requirements

Depending on the process step, different mixtures of acids, oxidizers, organic solvents and bases are used at temperatures up to 160°C. So every liquid-contacting part of a process pump has to be chemically resistant to these aggressive chemicals.

Any contamination of the medium with metallic ions or particles must be prevented, because this results in failure or degradation of chip performance. Therefore the medium may not be in contact with metallic parts inside a pump.

Because any operational failure entails enormous costs, process pumps have to be highly reliable and must operate with little maintenance to shorten facility down time as low as possible.

Today there exists no usable dynamic sealing, which fulfills these requirements and prevents any leakage of dangerous liquids. So only self-contained pump systems are applicable in wet process tools.