TO-115 • PT 1.2430
Peter Grünberg Institute
Quantum Nanoscience (PGI-3)

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Innovative Nanopositioner for Precise Object Manipulation: Enhancing Control and Reproducibility

Technology Description

Our technology is a novel nanopositioner designed to address specific challenges in precise object manipulation. It consists of at least one actuator with a movable support for the object and at least one spring element that applies a normal force between the object and the support. Unlike conventional nanopositioners, gravity plays only a minimal role in the normal force, which is mainly generated by the spring element. This allows the nanopositioner to work independently of its orientation. In addition, the spring element is connected to the support in such a way that constant tension is ensured regardless of the position of the object. This eliminates lateral forces that could hinder reproducible movements.

Problem

In the field of nanotechnology, there is a need to precisely move objects at the nanometer scale while also being able to move them over larger distances of micrometers to millimeters. Existing solutions use piezoelectric actuators, which can achieve subatomic precision but have limited displacement range. To combine subatomic precision with macroscopic displacement, slip-stick actuators have proven effective, where the object being moved is in frictional contact with the actuator. However, this approach requires defined friction conditions between the object and the actuator, specifically a defined normal force. Existing solutions either involve duplicating the entire actuator system or suffer from poor reproducibility and motion issues. The challenge is to provide a nanopositioner that applies a defined normal force without duplicating the entire actuator system. Our technology overcomes these issues.

Solution

The new nanopositioner shows several advantages over existing solutions. Firstly, it overcomes the limitations of slip-stick drives, where the contact between the support and the object needs to alternate between static and sliding friction. In previous designs, as the object moved further from its initial position, the movement became slower and

IP: PCT/DE2010/001316, DE102009057746.7, WO2011069476, EP2510560
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Keywords:
Nanopositioner, slip-stick actuator, scanning probe microscope, SPM, multi-tip STM

More Information
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As of 10/2023

less reproducible until it eventually got stuck. With the new nanopositioner, the normal force between the support and the object remains constant throughout the object's movement, resulting in more reliable and precise positioning. This is particularly beneficial when the object needs to be moved over a distance greater than the actuator's range of motion. The movable support and intermediate components can be made of materials like steel, ruby, quartz, or sapphire, which have proven to be advantageous for slip-stick operation.

Potential Use

The versatility of the novel nanopositioner makes it suitable for various applications. For example, it can be integrated into scanning probe microscopes (SPM), allowing the examination of different areas on an object's surface with macroscopic distances between them. By operating the nanopositioner as a slip-stick drive, where the object alternates between static and sliding friction with the support, different sample areas can be accessed and scanned. Furthermore, the nanopositioner can be used in ultrahigh vacuum environments, where manipulating multiple objects simultaneously presents a challenge. Its ability to maintain a constant normal force between the support and the object, even during movement, makes it ideal for such demanding conditions.

Development Status and Next Steps

Forschungszentrum Jülich has extensive expertise in this field and holds several patents. The technology described above has already been initially verified through prototypes and is continuously being developed further.

The Peter Grünberg Institute (PGI-3) – Quantum Nanoscience – already cooperates with numerous national and international companies and scientific partners. Forschungszentrum Jülich focuses on energy and cost-efficient devices, suitable for various emerging technologies. We are continuously seeking for cooperation partners and/or licensees in this and adjacent areas of research and applications.

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