

Detail

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TITLE OF INVENTION	SPIROGRAPH BASED MECHANICAL ASSEMBLY FOR FABRICATION, TESTING AND MEASUREMENT OF PRODUCT WITH NEAR UNIFORM CHARACTERISTICS
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Complete Specification

COMPLETE SPECIFICATION

Field of Invention:

The present invention relates to the fabrication of spirograph based variable mechanical system for performing various function like fabrication and manufacturing of fibre mat, processing of materials, testing and measurements to achieve near, uniform properties throughout the sample.

Background of the Invention

Manufacturing process like milling, electro discharge machining, grinding, polishing, coating etc. involve interaction of work piece and working head at perpendicular axis. The working head or work piece usually traverse longitude and latitude direction sequentially or circular pattern or any programmed pattern to achieve uniform characteristics like surface roughness, reflectivity etc. Similarly, testing methods like wear tester, non destructive evaluation (e.g. Eddy current, ultrasonic) involve above said movement with respect to testing unit and material

to be tested. Measurement techniques like surface roughness (noncontact-laser), glossiness and any sensing device follow sequential raster scan, fixed regular circular or programmed path. Electrospinning is an effective technique for the production of fibre mat product/scaffold with fibres of small diameters ranging from micrometers down to tens of nanometers with random tunable porosity. The Functional applications of electrospun nanofibres are biomedical, environmental protection, filtration, catalyst and enzyme carriers, sensors, energy harvest and storage etc. There are many variants of collector assembly by change in shape / geometry of collector and recess / hole along with/without rotation of collector.

The uniform characteristics of machined surface is always a concerning problem. There is always an attempt to increase the sampling of data of material via testing and measurements, to enhance the reliability of data. Patterning by laser micromachining generate pattern based on sequential raster movement or programmed movement such process is time consuming. In the case of electrospinning the electrospun mats are usually sectioned into many parts for application and which does not have any similar properties. Existing collector plates of electrospinning technique for producing mat either with use of static plate or rotating collector to produce mat with anisotropic properties and maximum along the fibre orientation direction. There is some loss of material in electrospinning process which doesn't reach the collector plate or edges of produced mat. In the invention reported the spiropath unit moves in spirograph path that intercepts maximum number of time at different radial direction among the defined area, whereby above mentioned drawbacks in existing design shall be overcome. The state - of - art related to the electrospinning fibre mat has been reported by introducing eccentricity between centre of collector plate and syringe. It was found that alignment of fibre dependent on the rotational speed of the collector and the eccentricity, in turn affecting the tensile strength. Similarly the techniques have reported for glass grinding with dressers at isolated multiple location of specific pattern and use of double disk eccentric grinding of wafer thinning for achieving flat surface uniformly throughout the sample.

Objective of the Invention:

The primary objective of the present invention is the fabrication of spirograph based mechanical system (SBMS) to process materials with near uniform properties for the purpose of fabrication, testing and measurement. The secondary objective of the present invention is the selection of spirograph pattern and meshing gear setup comprising outer fixed gear and inner movable gear. The third objective of the present invention is designing and positioning of the design pointer to which the spiropath unit is housed. The fourth objective of the present invention is the spiropath unit which can function either as working head or working piece. The fifth objective of the present invention is the ability to produce different varieties of multi oriented pattern by changing the position of design pointer on the internal gear onto which Spiropath unit is mounted. The final objective of the present invention is the design of SBMS for collector assembly of an electrospinning setup as a proof of concept.

Brief description of the prior art:

No such closest prior art is available to the present invention.

Summary of the invention:

The present invention relates to Spirograph based mechanical system to process materials with near uniform characteristics wherein this mechanical system can be applied for variety of applications like eletrospinning, polishing, wafer thinning, patterning, wear testing, thickness measurements, image scanning, fabrication of glass or carbon fibre and other processes like mixing and coating . The spiropath unit which could be either the work piece or work head of spirograph based mechanical assembly is set to move spirographically using meshing of internal and external gear assembly. The Mounting of work piece or work head on rotating internal gear through various positions of design pointer, the spirograph pattern can be changed. Furthermore the properties can be tuned by varying the spirograph pattern.

Brief Description of the Drawings:

The present invention relates to the spirograph based mechanical system to process the materials with near uniform properties, herewith the collector plate as a spiropath unit in the process of electrospinning is illustrated as a proof of concept.

Fig 1. Overview of Electrospinning unit with spirograph based mechanical System

Fig 2. Internal Gear with Design pointer

Fig 3. A typical Spirograph pattern

Fig 4. Meshing gear setup

Fig 5. Samples sectioned at different angles from electrospun fibrous mat

Fig 6. Tensile strength variation of samples sectioned at different angles from the electrospun fibrous mat

Fig 7. Tensile strain variation of samples sectioned at different angles from the electrospun fibrous mat

Fig 8. Young's Modulus variation of samples sectioned at different angles from the electrospun fibrous mat

Detailed description of the invention with respect to drawing:

The present invention is the Spirograph based mechanical system (SBMS) (1) to process materials with near uniform properties. This mechanical tool works on the principle of spirograph (2) which is a geometric tool for drawing mathematical roulette curves which is technically known as hypotrochoids and epitrochoids. This spirograph based mechanical tool can be applied for variety of applications like electrospinning (3), wafer thinning, patterning, thickness tester, mixer or agitator etc. The said mechanical tool comprises of meshing gears (4), design pointer (5), motor shaft and respective work piece or work head required for the

application.

Construction

The main objective of this construction is to achieve the spirograph movement of the design pointer which furthermore utilized for different applications with respect to the requirements. In order to achieve the spirograph path, a meshing of external fixed gear (6) and internal rotating gear (7) was employed. The gear of larger diameter is called external gear having its gear tooth in the inner circumference of the gear and which is fixed to the unit. The smaller diameter gear termed internal gear made to rotate inside the larger external gear under constant meshing without slipping. A connector (8) links centre of the internal gear at one end and motor shaft at the other end and holes are made on the internal gear at various locations based on the spirograph graphic drawing set to locate design pointer. The mentioned design pointers are holes onto which work piece or working head mounted and will follow spiropath defined by [roulette](#) curves. Different spirograph movement can be implemented by fixing the work piece or work head to the different design pointers. The different spirograph pattern was generated based on the position of design pointer. The position of pointer was selected by considering the design which produces more lines passing through its centre in all directions. The connector rotates the smaller gear meshing with stationary larger gear. The connector was powered by an electrical motor and regulator to vary the speed of revolution. A work piece or working head which follows spirograph path, henceforth mentioned as "spiropath unit" (9) Spiropath unit

The spiropath unit is fastened to the inner movable gear at the design pointer. The movement of spiropath unit is directly proportional to the movement of inner gear. The spiropath unit varies with respect to the application used. The spiropath unit act as working head in several applications like Polishing device wherein the polishing disc will be the movable attaching unit and stationary working piece will be the sample, similarly coating or smearing unit wherein movable attaching unit will be coating brush or injector and working piece will be sample to be coated. The spiropath unit can be used as a working piece in certain applications like electrospinning, wafer thinning, patterning, thickness tester, mixer or agitator etc. For example in electrospinning unit the collector plate (10) is the spiropath unit, the properties of fibrous mat, like mechanical property has near uniformity in all samples sectioned in different direction and location throughout the prepared mat with use of SBMS(II). The properties of electrospun mat like stiffness and porosity can be tuned by altering the spiropath of collector plate by changing the design pointer on the internal gear.

Industrial application of the invention

- Preparation of glass or carbon fibre mat or any other material producing near isotropic mechanical property instead of achieving by stacking of different oriented layers for composite preparation.
- Preparation of mat may be done with any kind of polymers which is reported to be electrospun, not limited to synthetic or natural polymer for wide variety of application from sensors to tissue engineering, wherein property like pore size, mechanical strength etc. will be more or less uniform in any part of mat prepared by spirograph based collector.

- Machining process like milling/ laser micro machining/ electro discharging machining, wafer thinning etc were work piece or working head can be set to move spirographically to achieve micro patterns more uniform throughout the sample.
- Measurements/ sensing/ testing involving traversing of tool, probe, spray gun, over a material as in the case of surface roughness/ profile measuring instrument, wear testing, cleaning, smearing, coating etc.

Claims:

We claim

1) A spirograph based mechanical assembly for fabrication, testing and measurement of product with near uniform characteristics comprises of

(a) an spirograph unit which moves spirographically in a specific pattern, the said spirograph unit comprises, collector plate for electrospinning, polishing disc for polishing , wafer mounting for wafer thinning apparatus, scanning head for scanner, agitator, injector, probe of a measuring tool, testing head, working head and thereof

(b) a meshing gear setup comprise internal movable gear and external fixed gear;

(c) a connector being for connecting the motor shaft and internal movable gear;

(d) a design pointer, wherein the internal gear comprising various holes which are made to fix the spirograph unit like collector plate, polishing tool, wafer mount, scanning head, agitator, injector, probe of measuring tool, testing head, working head and accordingly to produce different spirograph pattern;

2) The apparatus as claimed in the claim 1, wherein the said meshing gear setup comprises of external gear and internal gear, wherein further the outer circumference of the internal gear is in contact with the inner circumference of the external gear producing spirograph movement with respect to the design pointer's position.

3) The apparatus as claimed in the claim 1, wherein

(a) the said design pointers are the holes located on the internal gear similar to holes location of graphic tool set based on spirograph;

(b) the said spirograph unit is attached to the internal gear at the design pointer;

(c) the different placement of design pointer on the internal gear gives different pattern of spirograph movement which further produces the different multi-oriented pattern with more uniform properties.

- 4) The apparatus as claimed in the claim 1, wherein the centre or any other region of the spiropath unit shall be mounted to internal gear at the design pointer.
- 5) The apparatus as claimed in the claim 1, wherein the centre of the internal gear and the motor shaft is connected by the connector thereby increasing the stability to the internal gear during spiropath movement as well as to avoid slippage.
- (a) The apparatus as claimed in claim 1, wherein the said spiropath based [roulette](#) movement is also applicable in the machining process comprising milling, micro machining, electro-discharging machine, wafer thinning wherein the work piece or working head can be set to move spiropathically to achieve the desired pattern;
- 6) The apparatus as claimed in claim 1, wherein the said spiropath unit comprise of work piece or working head.
- 7) The apparatus as claimed in claim 1, wherein the said spiropath based mechanical assembly is applicable
- (a) in electrospinning for producing fibre mat with controllable multi orientated pattern or textures fibre; (i) furthermore the properties will be uniform in any section of the mat; (ii) any material which is reported to be electrospun shall be used for the production of mat of nano and/or micro dimensional fibre;
- (b) to the fabrication of glasses, carbon or any material fibre with isotropic properties in the applications thereof
- (c) for material processing wherein the material delivery or discharge over a substrate or medium shall be dispersed or layered with uniform characteristics;
- (d) for testing methods wherein the material to be tested or tester (sensor, scanner, probe, etc) when set as spiropath unit, will be more representative of sample of large area in shorter period of time.