

(19)



**Octrooi Centrum
Nederland**

(11)

2014597

(12) B1 OCTROOI

(21)

Aanvraagnummer: **2014597**

(51)

Int. Cl.:

G03F 7/16 (2006.01) **H01L 21/02** (2015.01) **H01L 21/67** (2015.01)

(22)

Aanvraag ingediend: **08/04/2015**

(43)

Aanvraag gepubliceerd:
12/01/2017

(73)

Octrooihouder(s):
**SUSS MicroTec Lithography GmbH
te Garching, , Germany, DE.**

(47)

Octrooi verleend:
20/01/2017

(72)

Uitvinder(s):
Omar Fakhr te Brunthal (DE).

(45)

Octrooischrift uitgegeven:
17/03/2017

(74)

Gemachtigde:
ir. J.M.G. Dohmen c.s. te Eindhoven.

(54)

Method and device for applying a coating to a substrate.

(57)

The invention relates to a device for applying a coating to a substrate, comprising a metering device, by means of which a coating fluid can be applied to the substrate as a jet, and a solvent dispenser, which is arranged eccentrically and to the side of the front end of the metering device, in such a way that a predetermined amount of solvent can be administered to the front end of the metering device. The invention also relates to a method for applying a coating to a substrate by means of a device according to any of the preceding claims, wherein, before the coating fluid is applied, a predetermined amount of solvent is brought to the front end of the metering device, in such a way that the solvent comes into contact with the coating fluid located there, and, after a waiting period, the coating fluid is subsequently applied to the substrate by means of the metering device.

Title: Method and device for applying a coating to a substrate

5 The invention relates to a device by means of which a coating fluid can be applied to a substrate as a jet and to a method for applying a coating to a substrate.

10 The substrate may in particular be a wafer from which for example chips or MEMSs (microelectromechanical systems) are subsequently produced. For this purpose, photolithography processes may for example be used. In this case, the coating is a photoresist (resist) to be applied uniformly to the substrate. One example of a process for applying the photoresist is spin-coating, in which the substrate is rotated whilst the photoresist is being applied. Under the effect of centrifugal force, the photoresist is distributed uniformly on the surface of the substrate.

15 However, the device according to the invention and the method according to the invention are not limited to coating a wafer with photoresist, but in principle relate to any coating where the coating fluid is applied to a substrate as a jet, in such a way that it forms a homogeneous coating thereon with as uniform a layer thickness and as planar a surface as possible.

20 It has been found that the start of the coating process is problematic in that air bubbles (or else gas bubbles for coating in a gas atmosphere) may occur when the coating fluid jet impacts on the substrate, the bubbles being subsequently located within the coating. Depending on the viscosity of the coating fluid and the further processing steps (for example an idle period), it is not always ensured that these air bubbles rise to the surface of the applied coating and are eliminated. If air bubbles remain in the coating, they form an inhomogeneity in the coating. Further, there is the risk that they may lead to local elevations in the surface of the coating, since they take up some volume.

25 The object of the invention is to provide a device and a method for applying a coating to a substrate which prevent the occurrence of air or gas bubbles when the coating fluid jet impacts on the substrate.

To achieve this object, the invention provides a device comprising a metering device, by means of which a coating fluid can be applied to the substrate as a jet, and a solvent dispenser, which is arranged eccentrically and to the side of

the front end of the metering device in such a way that a predetermined amount of solvent can be administered to the front end of the metering device. In the method according to the invention, before the coating fluid is being applied, a predetermined amount of solvent is brought to the front end of the metering device in such a way
5 that the solvent comes into contact with the coating fluid located there. After a waiting period, the coating fluid is subsequently being applied to the substrate by means of the metering device.

The invention is based on the underlying idea of slightly diluting the front portion of the jet of coating fluid which impacts on the substrate, by means of
10 the solvent. On the one hand, this reduces the tendency of the coating fluid to form air bubbles when it impacts on the substrate. The solvent appears to act as a lubricant in this context. On the other hand, the solvent leads to a slight dilution of the coating fluid such that any air bubbles which do occur can more easily rise to the surface of the coating and be eliminated. Since the solvent dispenser is arranged
15 eccentrically and to the side of the front end of the metering device, it does not disrupt the normal coating process. Further, it only takes up very little space, and so enough space is left around the metering device for any other required components.

In one embodiment of the invention, the solvent dispenser is a spray nozzle which is directed towards and can spray solvent onto the front end of the
20 metering device. This has the advantage that the solvent dispenser can be arranged at a distance from the front end of the metering device.

Preferably, the spray nozzle sprays the solvent in a direction substantially parallel to the plane defined by the front end of the metering device. As a result, the solvent is applied to the coating fluid located in the metering device in a
25 tangential direction so the solvent remains on the coating fluid as a drop and does not penetrate into the coating fluid in the form of small droplets as a result of the spray pressure.

In an alternative embodiment, the solvent dispenser is formed as an administering arm which can supply a drop of solvent to the metering device. In this
30 embodiment, a drop of solvent is produced at the front end of the solvent dispenser, comes into contact with the front end of the metering device, and subsequently moves, under the action of capillary forces, towards the coating fluid located in the metering device.

In one embodiment of the invention, the metering device and the solvent dispenser are adjustable relative to one another. This makes it possible to bring the drop produced at the solvent dispenser into contact with the metering device by bringing the solvent dispenser and the metering device close to one another and subsequently moving the two components apart again so that the solvent dispenser does not disrupt the coating process.

In a preferred embodiment, the coating fluid forms a concave meniscus at the front end of the metering device, and the solvent enters the meniscus. If it does not occur automatically as a result of the surface tension of the coating fluid, a meniscus of this type can be produced by pulling the coating fluid back slightly into the metering device after the end of the previous coating process. The meniscus makes it easier for the solvent to apply itself uniformly on the front end of the coating fluid contained in the metering device and thus on the front portion, which impacts on the substrate during coating, of the coating fluid jet.

The waiting period may be set as a function of the properties of the coating fluid and the solvent so as to prevent the occurrence of air bubbles in an optimum manner. In tests, waiting periods in the range of 10 to 120 s, preferably waiting periods of approximately 20 to 60 s, have been found to be suitable.

The coating fluid may be a photoresist. In this case, all materials normally used to dilute and/or treat photoresists of this type, for example acetone, are suitable as a solvent.

In the following, the invention is disclosed in greater detail with reference to various embodiments, which are shown in the accompanying drawings, in which:

- Fig. 1 is a schematic view of a device for applying a coating to a substrate in the initial state;

- Fig. 2 shows the device of Fig. 1 when solvent is being applied to the front end of the metering device;

- Fig. 3 is a schematic view of a second embodiment of a device for applying a coating to a substrate;

- Fig. 4 is a schematic sectional view of a coating fluid jet at the moment of impact on a substrate, the coating fluid having been treated using the device according to the invention and the method according to the invention;

- Fig. 5 is a schematic sectional view of the coating obtained using the coating fluid jet of Fig. 4 on the substrate;

- Fig. 6 shows in several schematic sectional views, in chronological succession, a coating fluid jet at the moment of impact on a substrate in a prior art coating process; and

Fig. 7 is a view corresponding to that of Fig. 5 of the coating obtained using the coating process of Fig. 6.

Fig. 1 schematically shows a device by means of which a coating fluid 2 can be applied to a substrate 3. The coating fluid 2 may for example be a photoresist (resist).

The coating fluid 2 is provided via a metering system 4, and can be applied to the substrate 3 in the form of a jet by a metering device 5. During application, the metering device and the substrate can be adjusted suitably relative to one another.

Using the device shown, in particular a coating method generally known as spin-coating can be carried out.

Fig. 1 shows the device between two coating processes. After the end of the previous coating process, the coating fluid 2 was sucked back slightly, and so the end face of the coating fluid located in the metering device 5 forms a concave meniscus 7.

The coating device is provided with a solvent dispenser 10, by means of which a predetermined amount of a solvent provided by a supply system 12 can be administered to the front end of the metering device 5. The solvent dispenser 10 is arranged eccentrically and to the side of the front end of the metering device 5, in other words outside the path of the coating fluid 2 from the metering device 5 to the substrate 3.

In the first embodiment shown in Fig. 1 and 2, the solvent dispenser 10 is a spray nozzle by means of which the solvent can be sprayed from the side of the metering device 10 onto said metering device and/or onto the meniscus 7. Either the solvent may be sprayed onto the metering device in such a way that it enters the meniscus 7 under the action of capillary forces, or the solvent may be sprayed directly into the meniscus 7 tangentially.

What is of decisive importance is that a suitable amount of solvent 14 is applied by means of the solvent dispenser 10, and is located in the region of

the meniscus 7 (see Fig. 2), in other words on the end face of the column of coating fluid located in the metering device 5.

Fig. 3 shows a second embodiment. The same reference numerals are used for the components known from the first embodiment, and in this regard
5 reference is made to the above explanations.

The difference from the first embodiment is that in the second embodiment the solvent dispenser 10 is configured as an administering arm, at the front end of which a drop of the solvent 14 can be produced. This drop is subsequently brought into contact with the front end of the metering device 5 or with
10 the meniscus 7 at the front end of the column of coating fluid 2 located in the metering device 5. For this purpose, the metering device 5 and the solvent dispenser 10 are adjusted suitably relative to one another, for example using a combination of radial and vertical movement.

When the substrate 3 is to be coated with the coating fluid 2, initially
15 the solvent 14 is applied to the end face of the column of coating fluid 2 located in the metering device 5. This can be done either by spraying (see Fig. 2) or by mechanically transferring a drop of solvent onto the metering device 5 (see Fig. 3).

The solvent is applied a predetermined length of time before the start of the coating process so that a desired waiting period can pass before the
20 coating fluid 2 is applied to the substrate 3 in the form of a jet.

The moment when the front end of the jet of coating fluid 2 impacts on the substrate 3 is shown schematically in Fig. 4. Fig. 4 also shows the solvent 14 which surrounds the front end of the jet of coating fluid 2. It has been found that, by using the solvent, air bubbles can be prevented from forming when the front end of
25 the jet of coating fluid 2 impacts on the substrate 3. This is possible due to the viscosity which is altered by the solvent. The solvent may possibly also act in the manner of a lubricant.

Fig. 5 schematically shows the coating fluid 2, which has been applied to the substrate 3 as a coating. It can be seen that there are no air bubbles enclosed in the coating and that the coating has a constant layer thickness as well
30 as a planar surface.

Fig. 6 schematically shows the impact of the front end of a jet of coating fluid 2 on a substrate 3, there not being any solvent at the front end of the jet.

When the front end of the coating fluid jet impacts on the substrate 3, an air film is formed (see Fig. 6a) which is laterally surrounded by the coating fluid 2. This air contracts such that, via an intermediate toroidal state (see Fig. 6b), it forms an air bubble (see Fig. 6c) which then remains in the formed coating as an air bubble 20 (see Fig. 7). Air bubbles of this type not only form an inhomogeneity in the coating, but also lead to a local bulge in the surface of the coating (see region 22).

CONCLUSIES

1. Inrichting voor het aanbrengen van een bekleding op een substraat (3), met een doseerinrichting (5), waarmee een bekledingsfluïdum (2) als straal op het substraat (3) kan worden aangebracht en met een oplosmiddeldisperser (10), welke excentrisch en zijdelings aan het voorste einde van de doseerinrichting (5) is geplaatst, zodanig dat aan het voorste einde van de doseerinrichting (5) een vooraf bepaalde hoeveelheid oplosmiddel (14) kan worden afgegeven.
2. Inrichting volgens conclusie 1, met het kenmerk, dat de oplosmiddeldispenser een sproeiventiel (10) is, dat naar het voorste einde van de doseerinrichting (5) is gericht.
3. Inrichting volgens conclusie 1, met het kenmerk, dat de oplosmiddeldispenser in de vorm van een applicatiearm (10) is uitgevoerd, welke een druppel oplosmiddel aan de doseerinrichting kan aanbieden.
4. Inrichting volgens conclusie 3, met het kenmerk, dat de doseerinrichting (5) en de oplosmiddeldispenser (10) relatief ten opzichte van elkaar instelbaar zijn.
5. Inrichting volgens een van de voorgaande conclusies, met het kenmerk, dat het bekledingsfluïdum (2) een fotolak is.
6. Werkwijze voor het aanbrengen van een bekleding op een substraat (3) door middel van een inrichting volgens een van de voorgaande conclusies, waarbij
 - vóór het aanbrengen van het bekledingsfluïdum (2) een vooraf bepaalde hoeveelheid oplosmiddel (4) op het voorste einde van de doseerinrichting (5) wordt gebracht zodanig, dat het oplosmiddel (14) met het zich daar bevindende bekledingsfluïdum (2) in contact komt;
 - na een wachttijd het bekledingsfluïdum (2) door middel van de doseerinrichting (5) op het substraat (3) wordt aangebracht.
7. Werkwijze volgens conclusie 6, met het kenmerk, dat het bekledingsfluïdum (2) aan het voorste einde van de doseerinrichting (5) een concave meniscus (7) vormt en dat het oplosmiddel (14) in de meniscus (7) terechtkomt.
8. Werkwijze volgens conclusie 6 of conclusie 7, met het kenmerk, dat het oplosmiddel (14) op het voorste einde van de doseerinrichting (5) wordt gespreid.

9. Werkwijze volgens conclusie 8, met het kenmerk, dat het oplosmiddel (14) in een richting wordt gespreeid welke in wezen evenwijdig is aan het vlak dat door het voorste einde van de doseerinrichting (5) wordt gedefinieerd.

5 10. Werkwijze volgens conclusie 6 of conclusie 7, met het kenmerk, dat de doseerinrichting (5) en de oplosmiddeldispenser (10) relatief ten opzichte van elkaar zodanig worden ingesteld, dat het oplosmiddel (14) aan het voorste einde van de doseerinrichting (5) terechtkomt.

10 11. Werkwijze volgens een van de conclusies 6 tot en met 10, met het kenmerk, dat de wachttijd in de grootte orde van 10 tot 120 sec bedraagt, bij voorkeur in de grootte orde van 20 tot 60 sec.

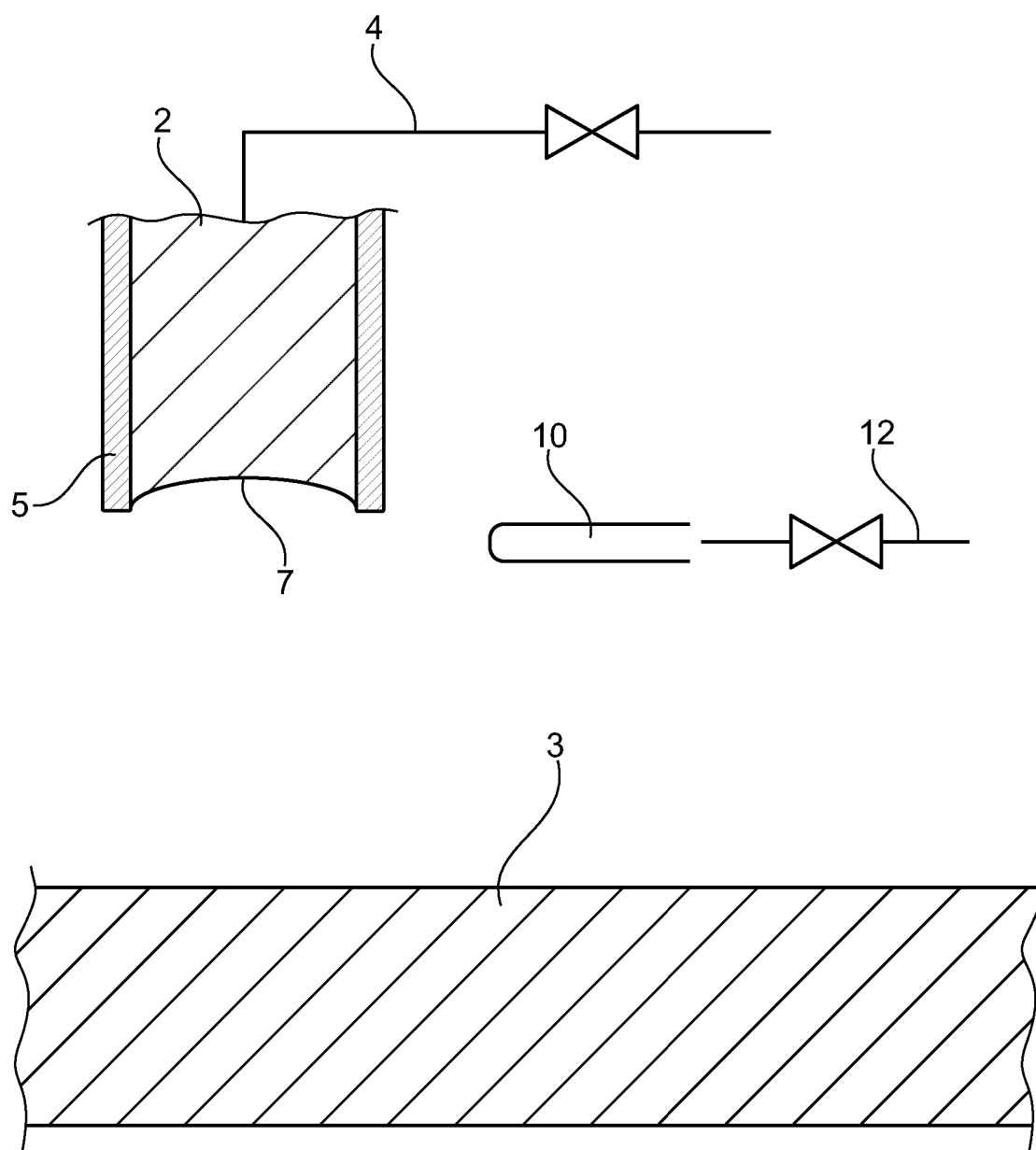


Fig. 1

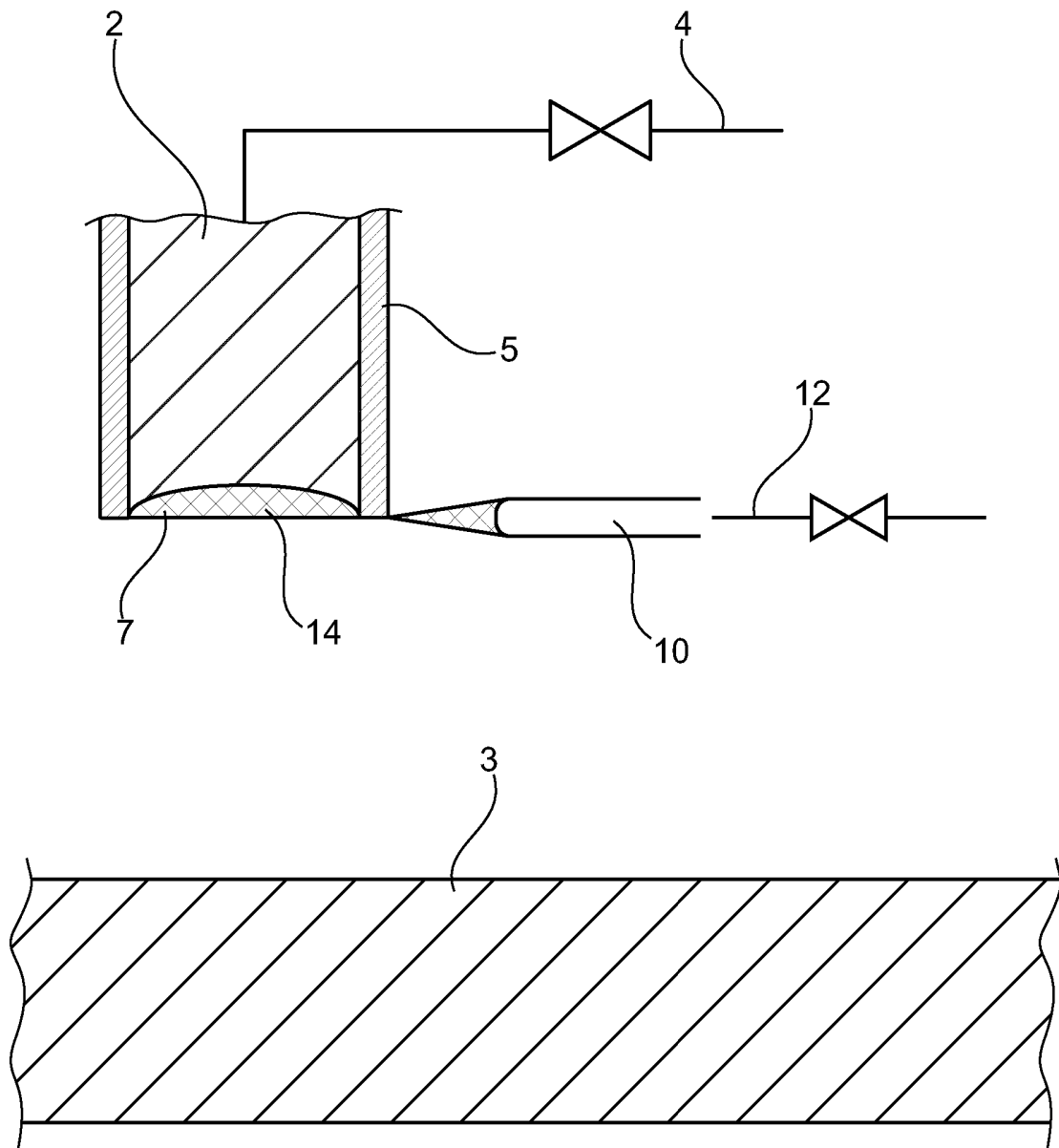


Fig. 2

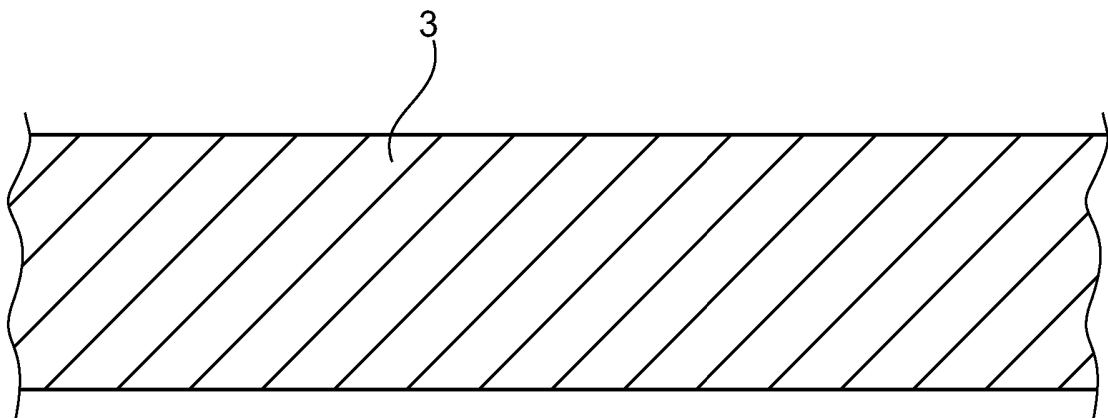
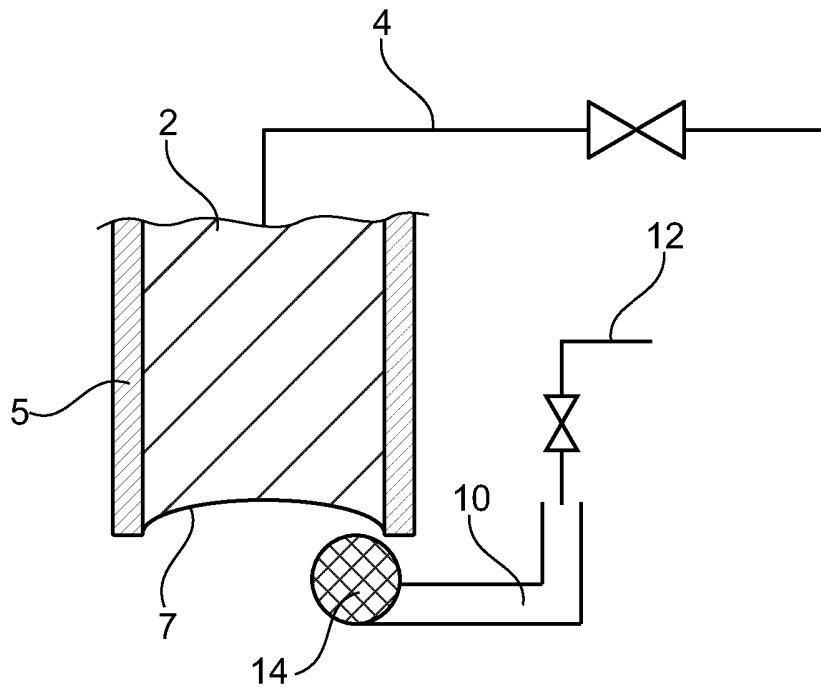


Fig. 3

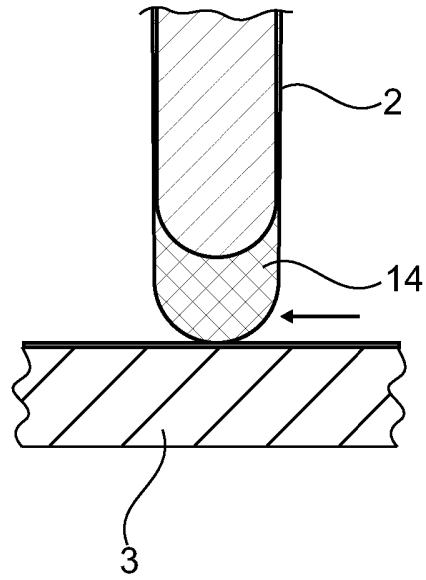


Fig. 4

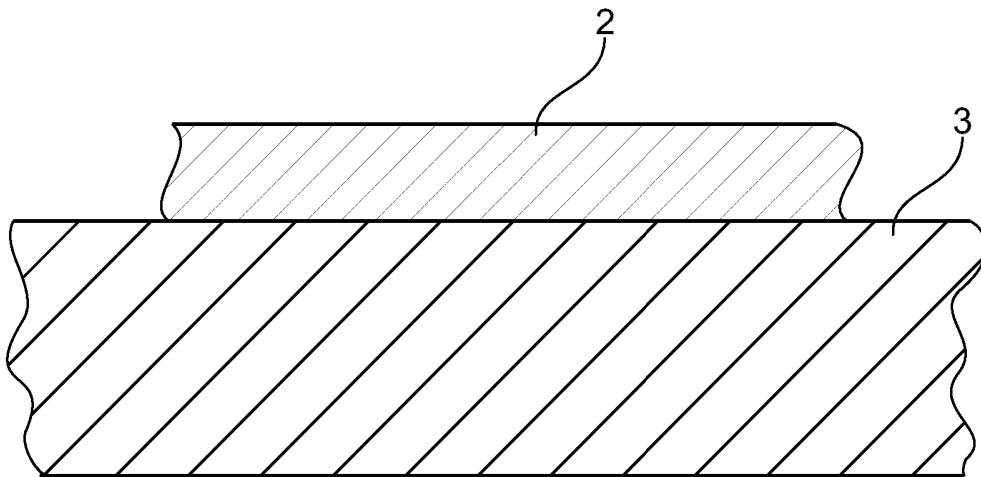


Fig. 5

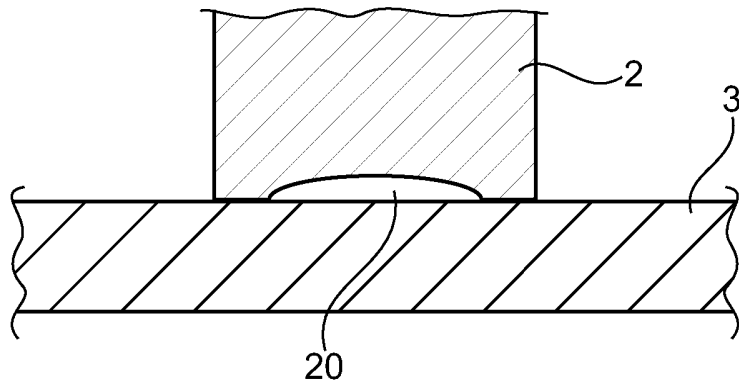


Fig. 6a

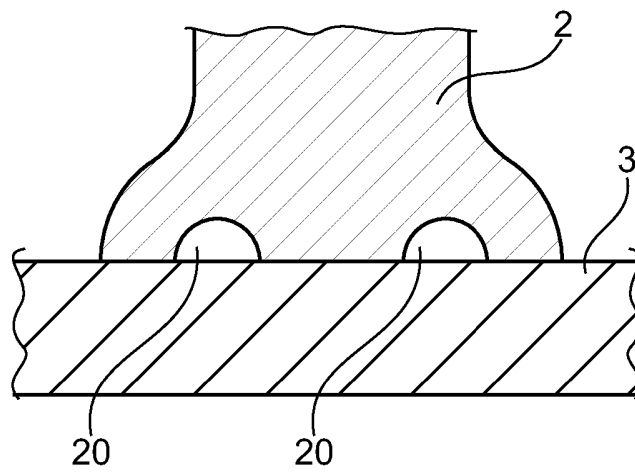


Fig. 6b

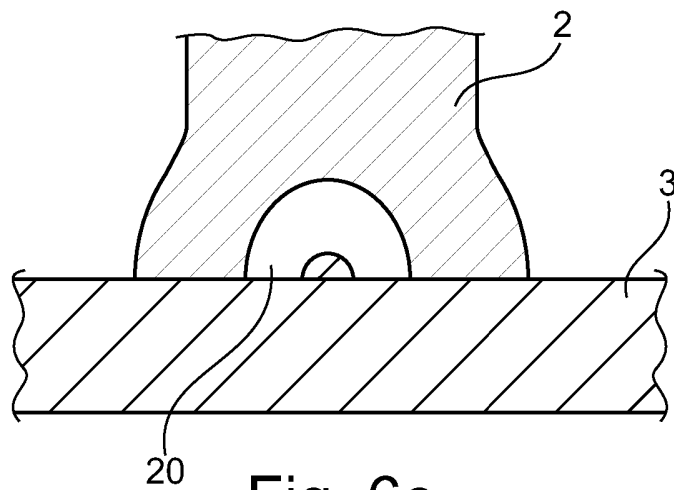


Fig. 6c

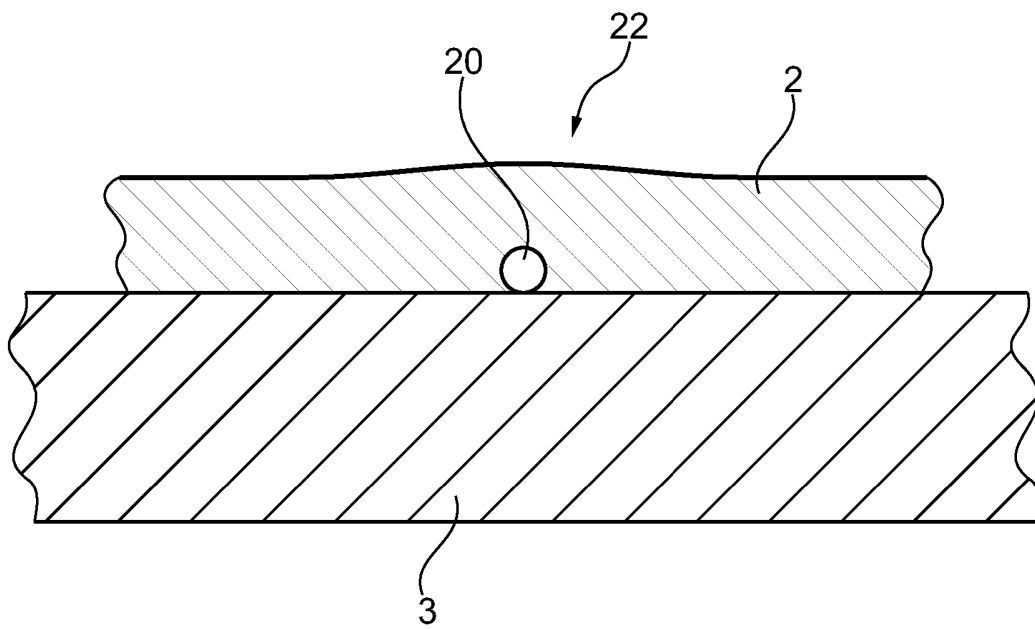
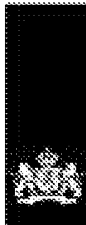


Fig. 7

ABSTRACT

The invention relates to a device for applying a coating to a substrate, comprising a metering device, by means of which a coating fluid can be applied to the substrate as a jet, and a solvent dispenser, which is arranged eccentrically and to the side of the front end of the metering device, in such a way that a predetermined amount of solvent can be administered to the front end of the metering device. The invention also relates to a method for applying a coating to a substrate by means of a device according to any of the preceding claims, wherein, before the coating fluid is applied, a predetermined amount of solvent is brought to the front end of the metering device, in such a way that the solvent comes into contact with the coating fluid located there, and, after a waiting period, the coating fluid is subsequently applied to the substrate by means of the metering device.



Rijksdienst voor Ondernemend
Nederland

OCTROOIAANVRAAG NR.
NO 139422
NL 2014597

ONDERZOEKSRAPPORT

BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK

RELEVANTE LITERATUUR			
Categorie	Literatuur met, voor zover nodig, aanduiding van specifiek van belang zijnde tekstgedeelten of figuren	Van belang voor conclusies nr.	Classificatie (IPC)
X	US 2001/033895 A1 (MINAMI TOMOHIDE [JP] ET AL) 25 oktober 2001 (2001-10-25)	1,5	INV. G03F7/16
A	* samenvatting; figuren 4-7 * * alinea [0049] * * alinea [0052] - alinea [0057] * * alinea [0060] - alinea [0062] * * alinea [0092] - alinea [0094] *	2-4,6-11	H01L21/02 H01L21/67
A	US 6 440 218 B1 (SANADA MASAKAZU [JP] ET AL) 27 augustus 2002 (2002-08-27) * samenvatting; figuur 1 * * kolom 7, regel 33 - kolom 8, regel 38 * * kolom 9, regel 34 - regel 40 *	1-11	
A	EP 0 540 447 A1 (IBM [US]) 5 mei 1993 (1993-05-05) * samenvatting; figuren 1,3 * * bladzijde 3, regel 55 - bladzijde 4, regel 39; voorbeelden * * bladzijde 4, regel 51 - bladzijde 5, regel 6 *	1-11	
A	WO 2007/127871 A2 (SOKUDO CO LTD [JP]; LIN Y SEAN [US]) 8 november 2007 (2007-11-08) * samenvatting; figuren 3A-3F * * bladzijde 11, regel 28 - regel 29 * * alinea [0046] - alinea [0052] *	1-11	Onderzochte gebieden van de techniek G03F H01L
A	WO 95/07765 A1 (MOBIUM ENTERPRISES INC [US]) 23 maart 1995 (1995-03-23) * samenvatting; figuur 1 * * bladzijde 4, alinea 3 - bladzijde 7, alinea 1 *	1-11	
Indien gewijzigde conclusies zijn ingediend, heeft dit rapport betrekking op de conclusies ingediend op:			
Plaats van onderzoek:		Datum waarop het onderzoek werd voltooid:	Bevoegd ambtenaar:
München		12 november 2015	Paissdor, Bernd
CATEGORIE VAN DE VERMELDE LITERATUUR			
X: de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur Y: de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geopenbaarde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht A: niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft C: niet-schriftelijke stand van de techniek P: tussen de voormengedatum en de indieningsdatum gepubliceerde literatuur T: na de indieningsdatum of de voormengedatum gepubliceerde literatuur die niet bezwaarlijk is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding E: eerdere octrooiaanvragen, gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven D: in de octrooiaanvraag vermeld L: om andere redenen vermelde literatuur B: na van dezelfde octrooiaanvrage of overeenkomstige octrooiaanvraag			

**AANHANGSEL BEHORENDE BIJ HET RAPPORT BETREFFENDE
HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK,
UITGEVOERD IN DE OCTROOIAANVRAGE NR.**

NO 139422
NL 2014597

Het aanhangsel bevat een opgave van elders gepubliceerde octrooiaanvragen of octrooien (zogenaamde leden van dezelfde octroofamilie), die overeenkomen met octrooschriften genoemd in het rapport.

De opgave is samengesteld aan de hand van gegevens uit het computerbestand van het Europees Octrooibureau per

De juistheid en volledigheid van deze opgave wordt noch door het Europees Octrooibureau, noch door het Bureau voor de Industriële Eigendom gegarandeerd; de gegevens worden verstrekt voor informatiedoeleinden.

12-11-2015

In het rapport genoemd octrooigeschrift		Datum van publicatie	Overeenkomst(e) geschrift(en)	Datum van publicatie
US 2001033895	A1	25-10-2001	JP 2001307991 A	02-11-2001
			US 2001033895 A1	25-10-2001
US 6440218	B1	27-08-2002	JP 3800282 B2	26-07-2006
			JP 2000157922 A	13-06-2000
			KR 20000035316 A	26-06-2000
			US 6440218 B1	27-08-2002
EP 0540447	A1	05-05-1993	EP 0540447 A1	05-05-1993
			JP H0734890 B2	19-04-1995
			JP H05208163 A	20-08-1993
			US 5449405 A	12-09-1995
WO 2007127871	A2	08-11-2007	TW 200808454 A	16-02-2008
			US 2007251450 A1	01-11-2007
			WO 2007127871 A2	08-11-2007
WO 9507765	A1	23-03-1995	EP 0719183 A1	03-07-1996
			JP H09502653 A	18-03-1997
			US 5403617 A	04-04-1995
			WO 9507765 A1	23-03-1995

SCHRIFTELIJKE OPINIE

DOSSIER NUMMER NO139422	INDIENINGSDATUM 08.04.2015	VOORRANGSDATUM	AANVRAAGNUMMER NL2014597
CLASSIFICATIE INV. G03F7/16 H01L21/02 H01L21/67			
AANVRAGER SUSS MicroTec Lithography GmbH			

Deze schriftelijke opinie bevat een toelichting op de volgende onderdelen:

- ☒ Onderdeel I Basis van de schriftelijke opinie
- ☐ Onderdeel II Voorrang
- ☐ Onderdeel III Vaststelling nieuwheid, inventiviteit en industriële toepasbaarheid niet mogelijk
- ☐ Onderdeel IV De aanvraag heeft betrekking op meer dan één uitvinding
- ☒ Onderdeel V Gemotiveerde verklaring ten aanzien van nieuwheid, inventiviteit en industriële toepasbaarheid
- ☐ Onderdeel VI Andere geciteerde documenten
- ☒ Onderdeel VII Overige gebreken
- ☐ Onderdeel VIII Overige opmerkingen

	DE BEVOEGDE AMBTENAAR Paisdor, Bernd
--	---

SCHRIFTELIJKE OPINIE

Aanvraag nr.
NL2014597

Onderdeel I Basis van de Schriftelijke Opinie

1. Deze schriftelijke opinie is opgesteld op basis van de meest recente conclusies ingediend voor aanvang van het onderzoek.
2. Met betrekking tot **nucleotide en/of aminozuur sequenties** die genoemd worden in de aanvraag en relevant zijn voor de uitvinding zoals beschreven in de conclusies, is dit onderzoek gedaan op basis van:
 - a. type materiaal:
 - ☐ sequentie opsomming
 - ☐ tabel met betrekking tot de sequentie lijst
 - b. vorm van het materiaal:
 - ☐ op papier
 - ☐ in elektronische vorm
 - c. moment van indiening/aanlevering:
 - ☐ opgenomen in de aanvraag zoals ingediend
 - ☐ samen met de aanvraag elektronisch ingediend
 - ☐ later aangeleverd voor het onderzoek
3. ☐ In geval er meer dan één versie of kopie van een sequentie opsomming of tabel met betrekking op een sequentie is ingediend of aangeleverd, zijn de benodigde verklaringen ingediend dat de informatie in de latere of additionele kopieën identiek is aan de aanvraag zoals ingediend of niet meer informatie bevatten dan de aanvraag zoals oorspronkelijk werd ingediend.
4. Overige opmerkingen:

SCHRIFTELIJKE OPINIE

Aanvraag nr.
NL2014597

Onderdeel V Gemotiveerde verklaring ten aanzien van nieuwheid, inventiviteit en industriële toepasbaarheid

1. Verklaring

Nieuwheid	Ja: Conclusies 2-4, 6-11 Nee: Conclusies 1, 5
Inventiviteit	Ja: Conclusies 2-4, 6-11 Nee: Conclusies 1, 5
Industriële toepasbaarheid	Ja: Conclusies 1-11 Nee: Conclusies

2. Citaties en toelichting:

Zie aparte bladzijde

Onderdeel VII Overige gebreken

De volgende gebreken in de vorm of inhoud van de aanvraag zijn opgemerkt:

Zie aparte bladzijde

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

- 1 Reference is made to the following documents:
 - D1 US 2001/033865 A1 (MINAMI TOMOHIDE [JP] ET AL) 25 oktober 2001 (2001-10-25)
 - D2 US 6 440 218 B1 (SANADA MASAHAZU [JP] ET AL) 27 augustus 2002 (2002-08-27)
 - D3 EP 0 540 447 A1 (IBM [US]) 5 mei 1993 (1993-05-05)
 - D4 WO 2007/127871 A2 (SOKUDO CO LTD [JP]; LIN Y SEAN [US]) 8 november 2007 (2007-11-08)
- 2 The present application does not meet the criteria of patentability, because the subject-matter of claims 1 and 5 is not new.

D1 discloses an apparatus (17, resist coating unit, cf. Fig. 4) for forming a film of a coating on a substrate (wafer W), with a metering device (discharge nozzle 70, with pump 75, pipeline 73 and tank 75), by means of which a coating fluid (resist solution, cf. par. 52) can be deposited as a jet on the substrate (wafer), and with a solvent dispenser (71, solvent vapor discharge nozzle), which is placed eccentrically and to the side of the front end of the metering device (cf. Fig. 5, nozzle 71 is placed on the nozzle holder 80 at the end of the arm 81, eccentrically and at the end of the metering device, i.e. discharge nozzle 70), such that at the end of the arm (81) holding the metering device (resist discharge nozzle 70) a predetermined amount of solvent (from solvent tank 76) can be delivered.

D1 furthermore explicitly disclosed a resist coating unit (17) and the delivery of photoresist (cf. par. 52, line 4).
- 3 The combination of the features of dependent claims 2, 3 and 4 is neither known from, nor rendered obvious by, the available prior art. The reasons are as follows: D1 does not disclose that the solvent discharge nozzle is directed to the resist discharge nozzle.
- 3.1 D2 discloses another apparatus for forming a resist coating on a substrate (W), having a coating solution supplying device (11) and a solvent spraying device (17a). But in D2 the solvent spraying device is not placed at the end of

the metering device, i.e. the coating solution supplying nozzle (11), but is held by separate arm (17); the nozzle (17a) is directed to the rotating substrate (the wafer W) and is adapted to spray the solvent over the entire surface of the wafer (cf. abstract; fig. 1; col. 7, l. 33 - col. 8, l. 38; col. 9, l. 34 - 40)

- 3.2 Document D3 discloses a device for spin coating of resist on a substrate (a wafer 14) in a chamber (10), with a resist spray (18) and a solvent vapor delivering nozzle (16) placed at a side wall of the chamber (10), a rotating chuck (12) driven by shaft (11). According to D3 the solvent vapor is sprayed in the enclosed chamber (10) prior to the spray coating of photoresist onto the substrate (14) (cf. abstract; Figs. 1,3; p. 3, l. 55 - p. 4, l. 39; example; p. 4, l. 51 - p. 5, l. 6)
- 3.3 D4 finally discloses a metering device for delivery of semiconductor processing liquid in general; in particular it is shown how a concave meniscus (316) of processing liquid (312) is used to determine the level of processing liquid in a deposition nozzle (264) (cf. abstract; Figs. 3A-3F; p. 11, l.28-29; par. [0046] - par. [0052])
- 3.4 Hence, a person skilled in the art would not have received an incentive from the available prior art to provide an apparatus with a nozzle according to claims 2, 3 or 4 in which the solvent is delivered at the end of a metering device from a spray nozzle in the direction of the top end of the coating liquid dispensing means, which can also be adapted to form solvent drops, and where the distance between solvent spray nozzle and coating liquid nozzle can be adjusted.
- 4 D1 is regarded as being the prior art closest to the subject-matter of claim 6, and discloses a method for coating a substrate (wafer W) with an apparatus (17, resist coating unit, cf. Fig. 4) for forming a film of a coating on a substrate (wafer W), with a metering device (discharge nozzle 70, with pump 75, pipeline 73 and tank 75), by means of which a coating fluid (resist solution, cf. par. 52) can be deposited as a jet on the substrate (wafer), and with a solvent dispenser (71, solvent vapor discharge nozzle), which is placed eccentrically and to the side of the front end of the metering device (cf. Fig. 5, nozzle 71 is placed on the nozzle holder 80 at the end of the arm 81, eccentrically and at the end of the metering device, i.e. discharge nozzle 70), such that at the end of the arm (81) holding the metering device (resist discharge nozzle 70) a predetermined amount of solvent (from solvent tank 76) can be delivered. The substrate is held in the resist coating unit (17) of D1 by the spin chuck (60); the solvent vapor discharge nozzle (71) is moved to a position above the periphe-

ral portion of the substrate (W), and while rotating a predetermined amount of solvent vapor is supplied to the peripheral portion of the wafer to improve the wettability of said part of the wafer (cf. par. 60).

- 5 The subject-matter of claim 6 differs from this known method in that the solvent vapor is not brought into contact with the resist delivery and metering device (nozzle 70 of D1) to allow contact with the coating fluid before it is dispensed onto the substrate and is therefore new.
- 5.1 The problem to be solved by the present invention may be regarded as the provision of a method and device as defined for instance by dependent claim 2 of the present application, said claim representing novel subject-matter, for coating a substrate which avoids the occurrence of air and gas bubbles when the coating liquid jet impacts the substrate.
- 5.2 The solution to this problem proposed in claim 6 of the present application is considered as involving an inventive step because the closest prior does not teach or suggest to bring the coating liquid into contact with a limited and predetermined amount of solvent at the top end of the delivery nozzle (i.e. the metering device for coating liquid) before it is delivered from the nozzle/metering device. The delivery of solvent to the periphery of a wafer according to D1 also aims at modulating/lowering the viscosity of the coating solution, but only because D1 wants to solve a different problem which is a gradual increase of viscosity of the coating solution in the periphery of a rotating wafer. In order to achieve uniform coating thickness, the solvent vapor is delivered at the periphery of the wafer and the viscosity of the coating solution is lowered. But according to D1 the viscosity of the coating fluid is lowered after the jet of coating fluid has been brought onto the substrate surface. Moreover, D1 and none of the other documents in the search report address the same technical problem which consists in avoiding the generating of air/gas bubbles in the coating, leading to local elevations and bulges. D1 and the other documents D2 to D4 only address the problem of achieving a uniform coating of even thickness, to control or reduce the amount of coating material deposited on a substrate.
- 6 Claims 7-11 are dependent on one or more independent claims whose subject-matter is considered as being new and inventive, as discussed above, and as such said dependent claims also meet the requirements of novelty and inventive step.

Re Item VII

Certain defects in the application

The relevant background art disclosed in documents D1 to D5 is not mentioned in the description, nor is this document identified therein.