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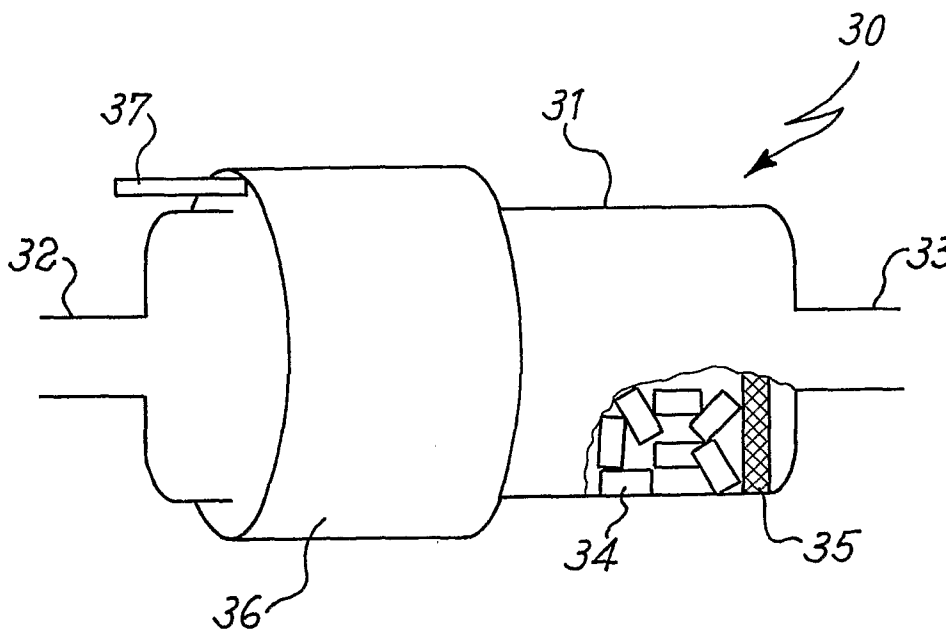
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(54) Title: USE OF NON-EVAPORABLE GETTER ALLOYS FOR THE SORPTION OF HYDROGEN IN VACUUM AND IN INERT GASES



(57) Abstract: It is described the use of non-evaporable getter alloys for hydrogen absorption inside evacuated chambers or from inert gases, both in applications where these latter represent the filling gas of device chambers, and for use in flows of the same gases for their purification.

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“USE OF NON-EVAPORABLE GETTER ALLOYS FOR THE SORPTION OF
HYDROGEN IN VACUUM AND IN INERT GASES”

The present invention relates to the use of non-evaporable getter alloys for the
5 absorption of hydrogen and to the applications exploiting such method. In particular, the
invention relates to the use of non-evaporable getter alloys having good hydrogen
absorption characteristics at relatively low temperatures.

A number of industrial or research applications require, for their proper working,
a hydrogen-free condition in a closed container; the space inside the container can be
10 kept under high vacuum or filled with an atmosphere of a given gas (or gas mixtures).
Examples of industrial applications where hydrogen is detrimental are evacuated jackets
for thermal insulation (e.g., in thermos or in solar collectors), due to the high thermal
conductivity of this gas; some kinds of lamps, wherein the presence of hydrogen in the
gas generally leads to variation of the physical parameters of the lamp functioning (e.g.,
15 the starting voltage); or X-rays production tubes. The production processes of these
devices comprise an evacuation step of the container and possible back-filling with the
desired gas, but any time a high vacuum or a hydrogen-free gas are obtained,
mechanisms exist tending to re-introduce this gas into the system; these mechanisms are
mainly the outgassing of the container walls and hydrogen permeation across these walls
20 from the outer atmosphere towards the container, thus leading to problems in the proper
working of said devices. Owing to the same mechanisms, hydrogen also represents the
main contribution to residual pressure in ultra-high vacuum (UHV) systems, for instance
particle accelerators used in research. Another relevant application is the purification of
inert gases such as argon, helium and nitrogen for the production of ultrapure gases used
25 in the production processes of the microelectronic industry.

In order to remove these traces of hydrogen, it is known to use non-evaporable
getter materials (known in the field as NEG's), namely, materials having the capability of
chemically fixing molecules of hydrogen as well as of other gases such as water, oxygen
and carbon oxides. Getter materials are generally metals of the III, IV and V group or
30 alloys thereof with other metals, generally transition metals or aluminum. The most
widely employed getter materials are titanium-based and, particularly, zirconium-based

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alloys. These materials and their use for absorbing gases from evacuated spaces or inert gases are well known and described in many patents, such as US 3,203,901 (disclosing zirconium-aluminum alloys), US 4,071,335 (zirconium-nickel alloys), US 4,306,887 (zirconium-iron alloys), US 4,312,669 (zirconium-vanadium-iron alloys), US 4,668,424
5 (zirconium-nickel-Rare Earths alloys, with the optional addition of one or more other metals), US 4,839,085 (zirconium-vanadium-E alloys, wherein E is an element chosen among Fe, Ni, Mn and Al), and US 5,961,750 (zirconium-cobalt-Rare Earths alloys).

As to hydrogen absorption in particular, it is also known the use of yttrium or solid mixtures containing it. Patent US 3,953,755 discloses the use of this element (protected
10 by thin layers of other metals) inside discharge lamps. Patent GB 1,248,184 discloses, for the absorption of hydrogen in various applications, the use of solid mixtures or intermetallic compounds of yttrium with other metals; in this patent it is required that yttrium be present in the form of a separate phase in an amount sufficient to perform the gettering function, and as a consequence the getter properties of the compositions of this
15 patent are essentially similar to those of pure yttrium. This feature is also attributable to the fact that with many of the metals listed in the patent (zirconium, titanium, niobium, hafnium, molybdenum, tantalum, tungsten and vanadium) yttrium forms neither compounds nor alloys, whereas with other metals (aluminum, beryllium, cobalt, copper, iron, magnesium, nickel, manganese and zinc) yttrium only forms intermetallic
20 compounds but not alloys (see the book "Constitution of Binary Alloys, First Supplement, edited by R. P. Elliott, McGraw-Hill, 1965), and the amounts of yttrium taught in patent GB 1,248,184 are in excess with respect to the amount that can be bonded in form of intermetallic compounds, so that at least part of it remains in form of pure metal. Finally, patent application WO 03/029502 discloses yttrium-rich yttrium-
25 vanadium and yttrium-tin compositions; in this case too the hydrogen absorption characteristics of the material are essentially those of pure yttrium.

NEG materials exhibit a hydrogen absorption behavior different from that towards other gases. While most gases are irreversibly chemically absorbed by these alloys, hydrogen absorption by NEGs is an equilibrium process, reversible as a function of
30 temperature: hydrogen is effectively absorbed at relatively low temperatures (below 200-400°C, depending on the chemical composition of the material), but it is absorbed

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with difficulty or even released at higher temperatures. Equilibrium characteristics in hydrogen absorption of these materials are generally graphically represented by means of curves giving, at different temperatures, the hydrogen equilibrium pressure over the alloy as a function of the concentration of hydrogen inside the NEG material.

5 Another characteristic of NEGs is that, in order to carry out their function, they generally require an initial treatment of thermal activation, at a temperature that may vary between about 300°C and about 900°C, lasting a time comprised between a few minutes up to some hours, depending on the material composition.

Advantageous characteristics for use of a NEG material as hydrogen absorber are
10 a low hydrogen equilibrium pressure and a low activation temperature.

Among the above-mentioned NEG materials, those with the better hydrogen absorption characteristics (low equilibrium pressure) are the zirconium-aluminum alloys, the zirconium-cobalt-Rare Earths alloys and yttrium. Of these, zirconium-aluminum alloys have a high activation temperature: in order to reach a good activation
15 of these alloys in not too long times it is necessary to treat them at temperatures above 700°C; this feature makes these alloys not suitable for some applications, for instance those in which the chamber to be kept hydrogen-free has glass walls, e.g., thermos or some lamps. Yttrium and the compositions of patent GB 1,248,184 (functionally similar to pure yttrium) only work well if kept at relatively high temperatures, higher than about
20 600°C. Zirconium-cobalt-Rare Earths alloys require lower activation and working temperatures, but they have hydrogen absorption characteristics (particularly, the equilibrium pressure) worse than those of yttrium.

There is thus in the field a continual need of alloys with improved hydrogen absorption properties compared to known NEG materials, especially as to the
25 characteristics of equilibrium pressure and activation temperature.

The present invention answers to this request, providing the use for hydrogen absorption in evacuated chambers or inert gases of non-evaporable getter alloys whose composition, plotted in a ternary diagram of weight percentage compositions, falls in the polygon defined by points:

- 30 a) Zr 54% - Y 1% - M 45%
b) Zr 50% - Y 5% - M 45%

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c) Zr 50% - Y 20% - M 30%

d) Zr 75% - Y 20% - M 5%

e) Zr 80% - Y 15% - M 5%

f) Zr 80% - Y 1% - M 19%

5 wherein M is an element chosen among aluminum, iron, chromium, manganese, vanadium or mixtures of these elements.

The invention will be described in the following with reference to the drawings, wherein:

- 10 - Figure 1 shows a ternary diagram in which is shown the field of possible compositions of the NEG alloys useful for the invention;
- Figures 2a-2f show some possible shapes of devices produced employing the NEG alloys suitable for the use of the invention;
- Figure 3 shows an inert gas purifier containing a NEG alloy for use in purification;
- 15 - Figures 4 and 5 show X-rays spectra of two alloys preferred for the use of the invention;
- Figures 6, 7 and 8 reproduce graphs showing the hydrogen absorption characteristics of some alloys suitable for the use of the invention and of some comparative alloys;
- 20 - Figures 9 and 10 reproduce graphs showing the hydrogen removal capability from inert gases of an alloy suitable for use of the invention and of a comparative alloy.

Figure 1 shows an alloys ternary diagram of compositions (in weight percentages), wherein the polygon defined by points a-f represents the field of non-evaporable getter alloys compositions suitable for the use of the invention.

Alloys suitable for the objects of the invention can be produced by melting in an oven, starting from chips or powders of the component metals, taken in ratios corresponding to the final desired composition. Preferred melting techniques are in induction oven, under vacuum or inert gas; or arc melting under a inert gas atmosphere, 30 for instance argon at a pressure of 3×10^4 Pascal (Pa). It is anyway possible to operate according to other common techniques in the metallurgical field for the preparation of

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alloys. Melting requires temperatures higher than about 1000°C.

Contrary to the compositions of patent GB 1,248,184 and of application WO 03/029502 described before, wherein yttrium is present as a separate phase only mechanically mixed with other components, the materials useful for carrying out the present invention are true alloys, as shown in the diffraction X-rays spectra of Figures 4 and 5, discussed below in connection with the examples.

For the uses of the invention, the cited alloys are employed in the form of devices made of pills of the getter material alone, or of this on a support or in a container; it is preferred the use of the alloys in the form of powders, with grain size generally lower than 250 micrometer (μm) and preferably comprised between 40 and 125 μm . With higher grain sizes the material specific surface (surface area for weight unit) gets too low, with consequent reduction of the gas absorption characteristics, particularly at temperatures lower than about 200°C; grain sizes below 40 μm , although usable and even required in some applications, pose flammability problems.

Shapes of getter devices that can be produced using the alloys suitable for the invention use are the most various, comprising pills made of powders of the getter alloy only, or of these on a metallic support. In both cases the strengthening of powders can be carried out through compression or sintering. Pills of sole compressed powders find application for instance in thermal insulation of thermos. In the cases in which the powders are supported, in general steel, nickel or nickel alloys of nickel-plated iron (namely, an iron support with a thin layer of nickel, typically in the range of a few micrometers) are used as material for the support. The support may be simply in the form of a tape onto whose surface the alloy powders are caused to adhere through cold rolling or by sintering after deposition according to various techniques; getter devices obtained by such tapes are used in lamps. The support may also be in the form or an actual container, having the most various shapes, into which the powders are inserted generally through compression or even without compression in certain devices wherein the container is provided with a porous septum, permeable to the passage of gases but capable of retaining powders. A few of these possible shapes are represented in Figures from 2a to 2f: Figure 2a represents a pill 20 made only of compressed powders of NEG alloy; Figure 2b represents a NEG device 30 made of a metallic tape 31 on which are

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present powders 32 of NEG alloy; Figure 2c represents in cross-section a NEG device 40 made of a metallic container 41 with an upper opening 42, inside which are present powders of NEG alloy 43; and Figure 2d represents in cross-section a NEG device 50 made of a metallic container 51 inside which are present powders of NEG alloy 52, with an upper opening closed by a porous septum 53. Figures 2e and 2f show a device made of a support 60, formed starting from a metallic sheet 61: in the sheet is first produced by pressing in a suitable mould (not shown) a hollow 62, after which part of the bottom of the hollow is removed through shearing, obtaining a hole 63; the support is kept in the forming mould and the hollow is filled with powders of the alloy, that are then compressed *in situ* obtaining device 70 (viewed in cross-section along line A-A' of Fig. 2e) wherein the powders tablet, 71, presents two exposed surfaces, 72 and 73, for the absorption of gas.

NEG alloys suitable for the use of the invention may be activated with treatments of a few minutes at 500°C, or at about 300°C for times of one or two hours, thus under milder conditions than those typically required by the zirconium-aluminum alloys (temperatures of about 800-900°C); besides, they exhibit good hydrogen absorption properties at lower temperatures than those required when using yttrium or prior art compositions containing this element.

In the specific case that hydrogen is to be absorbed from a nitrogen atmosphere, and in particular if at high temperatures, the inventors have found particularly suitable the use of alloys in which M is iron, as these alloys do not practically absorb nitrogen at temperatures up to 500°C so that the presence of this gas does not interfere with their hydrogen absorption properties. In this specific case, some preferred alloys are those of weight percent compositions Zr 69% - Y 10% - Fe 21%, Zr 61% - Y 20% - Fe 19%, Zr 65% - Y 15% - Fe 20% and Zr 74% - Y 10% - Fe 16%, represented by points g, h, i and l, respectively, in Figure 1.

The invention is useful in various industrial applications, for instance in inert gas purifiers for microelectronic industry. Figure 3 shows a typical embodiment of a purifier 30, made of a metallic cylinder 31 with an inlet 32 for the gas to be purified and an outlet 33 for the purified gas; on such lines are typically mounted shut-off valves (not shown) that may be either automatic or hand-controlled. The getter alloy to be used

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according to the invention is present in the form of pills, 34, retained inside the purifier by means of barriers 35 permeable to gas but capable of retaining both the purifier material and possible particles released by it; typically, such barriers are formed of particle filters with average pore dimensions comprised between 0.003 μm and 10 μm , sold e.g. by Mott Corporation. Around the metallic body of the purifier is present a heating means 36 and at least a sensor 37 for measuring temperature, commonly a thermocouple. Inside the purifier may be present more than one purifying materials, each one endowed with its own absorption characteristics towards given impurities. Among gases that can be purified there are argon, nitrogen, helium and their mixtures.

Another important application of the invention is in fluorescent lamps or, particularly, in discharge lamps comprising a burner inserted in a protecting jacket. The jacket protects the burner both mechanically and from chemical attack of atmospheric gases, given the fact that during operation of these lamps the burner walls may reach temperatures comprised between about 700 and 1000°C (depending on the lamp type).

In this second case the jacket may be either evacuated or filled with an inert gas such as argon or nitrogen, with typical filling pressures in the range 500-700 hPa. In these lamps the NEG alloy is placed in the jacket, keeping the inner space hydrogen-free thus avoiding that this gas may permeate across the burner walls and come to alter the proper working of the latter. In case the jacket is filled with nitrogen, the use of Zr-Y-Fe alloys, particularly those corresponding to points g, h, i and l of Figure 1, is preferred. The mentioned NEG alloys may be inserted in the protecting jacket of lamps in any of the forms shown in Figures 2a-2f, but it is preferred the use of devices made according to the forms shown in Figures 2b and 2f.

Other uses according to the invention are for keeping vacuum in evacuated jackets in order to improve thermal insulation characteristics (e.g. in thermos), in which case the alloy is preferably used in the form of pills (Fig. 2a); and in ultra-high vacuum systems such as particle accelerators, in which case the preferred form are the tapes of Figure 2b.

The invention will be further illustrated by the following examples.

EXAMPLE 1

This example describes the preparation of some alloys suitable for the use of the invention.

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A series of alloys are produced starting from the metallic components in the form of powders, adopting the weight ratios given in Table 1, that reports the weight in grams of each element and the nature of metallic element M in the different samples:

Table 1

Sample No.	Metal M	Zr (grams)	M (grams)	Y (grams)
1	Fe	69	21	10
2	Fe	61	19	20
3	Fe	65	20	15
4	Fe	64	26	10
5	Fe	74	16	10
6	Mn	70	20	10
7	Cr	77.5	12.5	10
8	Al	75.5	14.5	10
9	V	63	27	10

5

The powders are mixed and placed in a water-cooled copper crucible in an electric-arc oven, under an atmosphere of 3×10^4 Pa of argon. The temperature reached by the mixture during melting is of about 2000°C, which is kept for about 5 minutes. As the preparation takes place in an electric-arc oven with the starting materials in a water-cooled copper crucible, thus under conditions of a strong thermal gradient (so-called “cold feet” technique), in order to improve homogeneity of the alloy the ingot melting is repeated four times. The ingots obtained after cooling of the melts are ground and the resulting powders are finally sieved, recovering the grain-size fraction comprised between 40 and 105 μm .

10

15

Compositions of samples 1 and 2 correspond respectively to points g and h of the ternary diagram of Figure 1. Part of such powders is used for the obtainment of X-rays diffraction spectra shown in Figure 4 and Figure 5 for samples 1 and 2.

The remainder powder of samples 1 and 2 and the powders of the other samples are used to produce pills of the same samples; such pills are obtained compressing 120 mg of powders applying a pressure of 2000 Kg/cm^2 .

20

EXAMPLE 2 (COMPARATIVE)

This example refers to the preparation of a sample of an alloy of zirconium, cobalt and mischmetal (mischmetal is a commercial mixture of lanthanum and Rare Earths); characteristics and preparation of these alloys are described in US Pat. No. 5,961,750.

5 80.8 g. of zirconium, 14.2 g of cobalt and 5.0 g of mischmetal of approximate weight percent composition 50% cerium, 30% lanthanum, 15% neodymium and the remainder 5% of other Rare Earths, are weighed. The procedure of example 1 is repeated, preparing in this case too a series of identical pills. In the following this sample will be referred to as sample 10.

EXAMPLE 3 (COMPARATIVE)

10 This example refers to the preparation of a mixture having the same weight percent composition of the alloy of example 1, but made up of powders of an alloy of zirconium and iron only and powders of yttrium.

15 The zirconium-iron alloy is produced as in example 1, starting from 69 g of zirconium and 21 g of iron in powder, melting the powders, letting them to solidify, grinding the thus obtained ingot and recovering by sieving the grain-size fraction comprised between 40 and 105 μm . 10 g of yttrium of same grain-size are added to the thus obtained powders; with this powders mixture a series of identical pills is prepared, as described in example 1. In the following this sample will be referred to as sample 11.

EXAMPLE 4

20 A hydrogen absorption test is carried out on pills of samples 1, 2, 10 and 11. Each pill is activated at 500°C for 10 minutes. Absorption tests are carried out according to procedure described in standard ASTM F 798-82, with a test temperature of 400°C and a hydrogen pressure of 4×10^{-3} Pa. In the field, these tests are referred to as carried out
25 under “dynamic conditions” as the test chamber is fed with a variable flow of hydrogen, such as to have a constant hydrogen pressure over the pill.

30 The results of these tests are reported in graph in Figure 6, as absorption speed, S, measured in cubic centimeters of hydrogen absorbed per second and per gram of alloy ($\text{cc/s} \times \text{g}$), as a function of the amount of absorbed hydrogen, Q, measured in cubic centimeters of gas multiplied by the absorption pressure (in Pascal) and normalized per gram of alloy ($\text{cc} \times \text{Pa/g}$); the numbering of curves corresponds to that of the samples,

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the thick lines being used for samples for use according to the invention and the thin lines for comparative samples 10 and 11.

EXAMPLE 5

It is measured the hydrogen equilibrium pressure of another pill of an alloy
5 suitable for use according to the invention, prepared as described in example 1.

The measuring system is made of a glass bulb connected to a pumping system through a liquid nitrogen trap, helping to keep a low baseline pressure during the test; the sample is radio-frequency heated from outside the bulb through an induction coil. The system is evacuated until a residual pressure of 1×10^{-4} Pa is reached. Under
10 pumping, the sample is activated at 700°C for an hour by radio-frequency heating. At the end of the activation process the sample is brought at a temperature of 600°C and the bulb is disconnected from the pumping system. A measured amount of hydrogen is let into the bulb, and the trend of pressure is measured with a capacitive manometer; the pressure value at which the system reaches a steady state is the equilibrium pressure
15 under the given conditions. This procedure is repeated some times, letting into the system each time different amount of hydrogen. From the measure of the equilibrium pressures, being known the system volume and the weight of alloy, the concentration of hydrogen absorbed by the alloy under the different test conditions is obtained. The values of equilibrium pressure, P, measured in hectoPascal (hPa), are reported in graph
20 in Figure 7 (curve 1) as a function of the absorbed hydrogen concentration, C, measured in cubic centimeters of gas multiplied by the absorption pressure and normalized per gram of alloy (cc × hPa/g).

For comparison, in the graph in Figure 7 are also shown two curves relating to the
hydrogen equilibrium pressure of two alloys regarded in the field as particularly suited
25 for hydrogen absorption, namely, a zirconium-cobalt-mischmetal alloy prepared as described in example 2 (curve 10) and a zirconium-aluminum alloy described in US Pat. No. US 3,203,901 (curve labeled as Zr-Al); curves 10 and Zr-Al are sections of curves obtained averaging the data obtained in numerous tests carried out in the past with such known alloys adopting the same procedure above described for sample 1.

EXAMPLE 6

It is carried out a series of hydrogen absorption tests on sample 1 and on samples

3-11. These tests are carried out under so-called in the field "static conditions", namely, hydrogen is let into the chamber in subsequent dosages, closing the chamber between any two subsequent feedings; the system and the measuring procedure are described in detail in the paper "The properties of some zirconium-based gettering alloys for hydrogen isotope storage and purification", C. Boffito *et al.*, published in "Journal of Less-Common Metals" (1984), vol. 104, page 149.

The tests are carried out under the following conditions:

- initial hydrogen dosing pressure in each addition of 1×10^{-1} hPa;
- getter alloy temperature of 400°C;
- 10 - no thermal activation of the getter.

The curves obtained in these tests are shown in Figure 8, reporting for each sample the hydrogen pumping speed S (in cc × hPa); the numbering of the curves is after the numbering of samples.

EXAMPLE 7

15 Alloys of samples 5 (example 1) and 10 (comparative example 2) are tested to check their hydrogen removal capability from an inert gas flow.

100 mg of alloy of each sample in form of powder are compressed to form a pill and placed in a glass bulb kept under a flow of purified argon for about 2 hours; in both cases the alloys are not subjected to a pre-activation thermal process. Subsequently the pill is exposed to a 250 cc/min flow of inert gas containing 1% of hydrogen; the removal capability of the alloy is evaluated at three different temperatures, 300°C, 400°C and 500°C, radio-frequency heating the device containing the getter material powder. The amount of absorbed hydrogen is determined by measuring with a gas chromatograph the residual amount of hydrogen present in the gas flow exiting the bulb.

25 The results of the tests in nitrogen flow are shown in Figure 9, while those obtained with an argon flow are shown in Figure 10, in which with the thick line are reported the results obtained for sample 5, while the thin line has been used for the results relating to sample 10.

The results of the previously described tests are discussed below.

30 The diffraction spectra reported in Figures 4 and 5 relate to Zr-Y-Fe alloys containing 10 and 20% by weight of yttrium, respectively; the diffraction spectra show

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the peak intensities (I , in arbitrary units, a.u.) as a function of the reflection angle (2θ); the vertical lines reports in the spectra respectively at 2θ angles of about 28.3° , 31.2° , 32.3° and 42.6° , represent the positions and relative intensities of pure yttrium peaks. The main peaks in the two spectra do not correspond to those of yttrium; furthermore, in the case of the alloy containing 10% by weight of yttrium, there are essentially no peaks in positions corresponding to those of pure yttrium, confirming that in this case yttrium is present completely in alloy with zirconium and iron, while in the case of the composition at 20% of yttrium "shoulders" are observed, that can be attributed to yttrium along with the main peaks.

10 The graph of Figure 6 confirms that the alloys suitable for the use of the invention have hydrogen absorption properties at least equal to those of a zirconium-cobalt-mischmetal alloy of the prior art, regarded as particularly suited for the sorption of this gas; these alloys are besides clearly superior in hydrogen absorption compared to the mixture between a Zr-Fe alloy and pure yttrium of example 3 (curve 11), and this too is a confirmation that yttrium forms a true alloy in the compositions suitable to carry out the invention (particularly meaningful is the comparison between the hydrogen absorption capability of samples 1 and 11, being the composition of such samples nominally identical).

20 The graph shown in Figure 8 provides similar results, all compositions suitable for the use of the invention (curve 1 and curves 3-9) show a better hydrogen absorption compared to the alloy described in example 2 (curve 10), widely used in the field for hydrogen sorption, as well as compared to the mixture described in example 3 (curve 11).

25 Finally, curve 1 in Figure 7 shows the trend of hydrogen equilibrium pressure over sample 1 compared to analogous curves relating to alloys widely used in the field for hydrogen absorption. This graph too shows that an alloy suitable for use of the invention exhibits a hydrogen equilibrium pressure lower by nearly one order of magnitude compared to known alloys activated and tested under the same conditions (activation at 700°C and test temperature of 600°C).

30 The results reported in Figure 9 show that the alloys useful for carrying out the invention exhibit good characteristics of hydrogen absorption from a nitrogen flow; in

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fact, the results obtained with sample 5 (curve 905 in figure) are comparable to those obtained with sample 10 of comparative example 2 (curve 910 in figure), and particularly that the sample according to the invention has more constant hydrogen absorption properties with varying temperature compared to the sample of the prior art.

5 In Figure 10 are reported the results obtained for hydrogen removal from an argon flow; in this case the capacities measured for sample 5, curve 1005, are always superior to those obtained with sample 10, curve 1010.

10 The alloys suitable for use of the invention have a hydrogen equilibrium pressure lower than that of known alloys of similar composition, and at the same time activation and working temperatures lower than that of yttrium or of known compositions containing this element; as a consequence, these alloys are particularly suitable for industrial applications wherein is necessary the removal of this gas, both from evacuated chambers and from inert gases.

CLAIMS

1. Use for hydrogen absorption in evacuated chambers or in inert gases of non-evaporable getter alloys whose composition, plotted in a ternary diagram of weight percentages, falls in the polygon defined by points:

- a) Zr 54% - Y 1% - M 45%
- b) Zr 50% - Y 5% - M 45%
- c) Zr 50% - Y 20% - M 30%
- d) Zr 75% - Y 20% - M 5%
- e) Zr 80% - Y 15% - M 5%
- f) Zr 80% - Y 1% - M 19%

wherein M is an element chosen among aluminum, iron, chromium, manganese, vanadium or mixtures of these elements.

2. Use according to claim 1 in which hydrogen absorption takes place inside an evacuated chamber.

3. Use according to claim 1 in which hydrogen absorption takes place inside a chamber filled with an inert gas.

4. Use according to claim 1 in which hydrogen absorption takes place in an inert gas flow.

5. Use according to one of claims 3 or 4 in which said inert gas comprises argon, nitrogen, helium or their mixtures.

6. Use according to claim 1 in which, when the inert gas is nitrogen, element M of the non-evaporable getter alloy is iron.

7. Use according to claim 6 in which the weight percent composition of said alloy is Zr 69% - Y 10% - Fe 21%.

8. Use according to claim 6 in which the weight percent composition of said alloy is Zr 61% - Y 20% - Fe 19%.

9. Use according to claim 6 in which the weight percent composition of said alloy is Zr 65% - Y 15% - Fe 20%.

10. Use according to claim 6 in which the weight percent composition of said alloy is Zr 74% - Y 10% - Fe 16%.

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11. Use according to one of claims from 6 to 10 in which hydrogen absorption takes place in a jacket for protection of the burner of a lamp.

Fig. 1

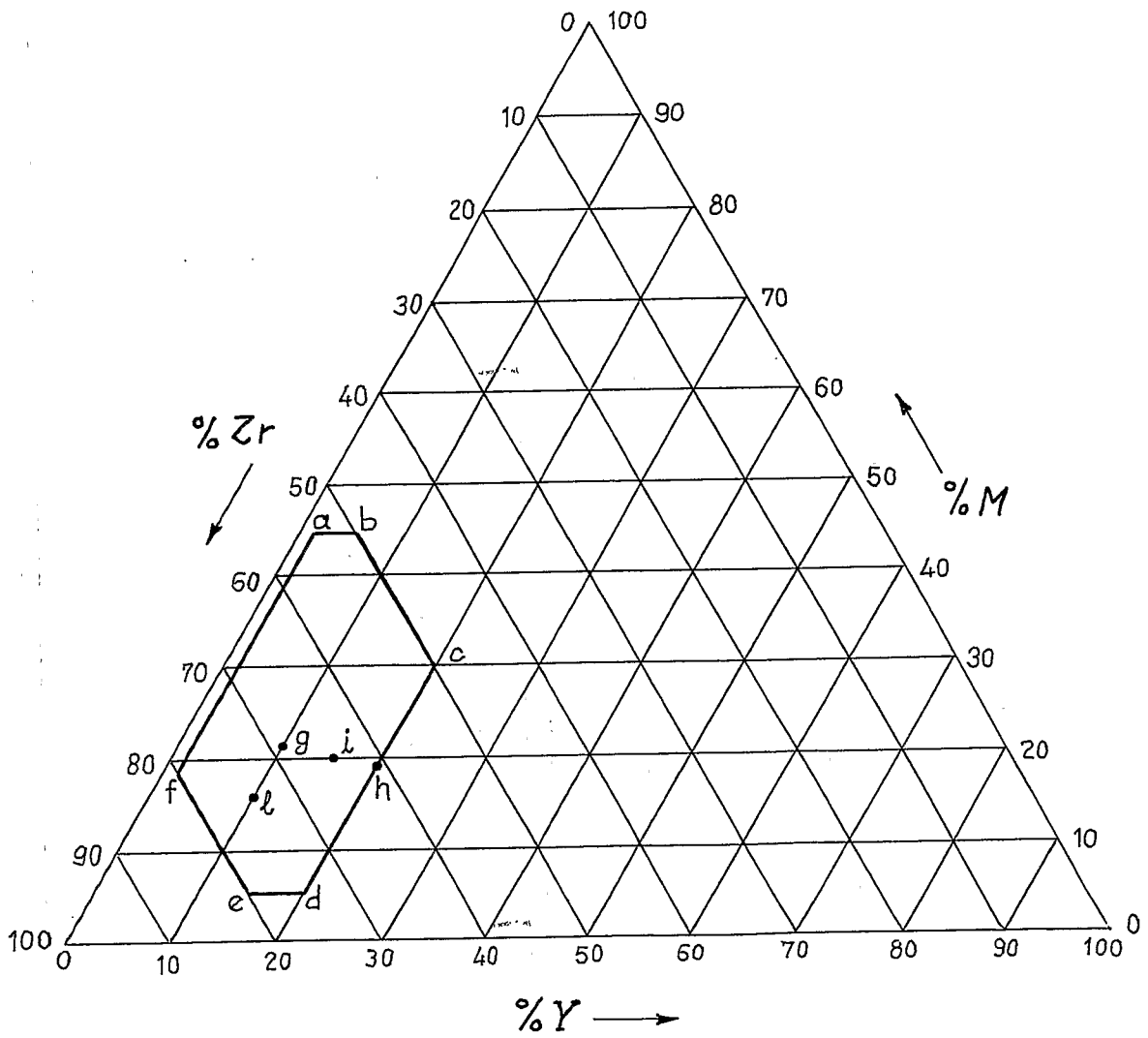


Fig. 2a

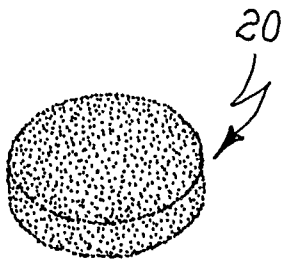


Fig. 2b

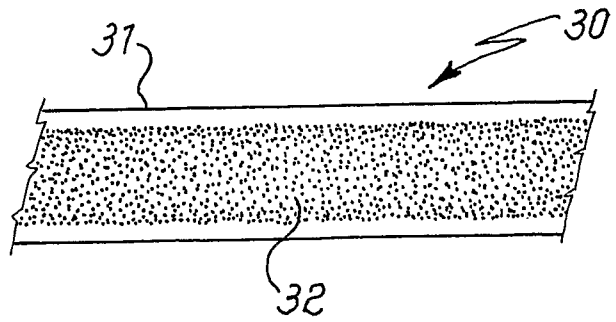


Fig. 2c

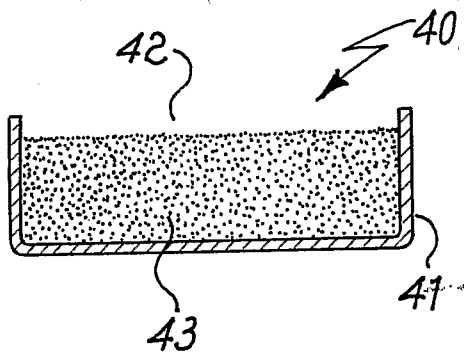


Fig. 2d

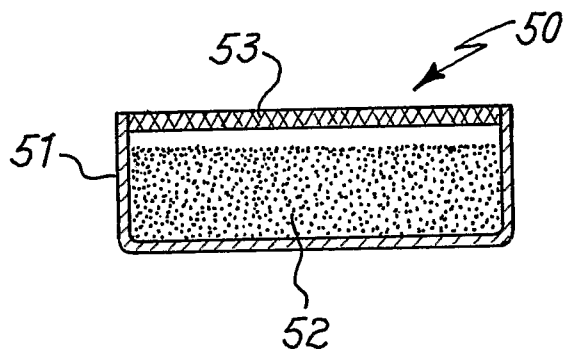


Fig. 2e

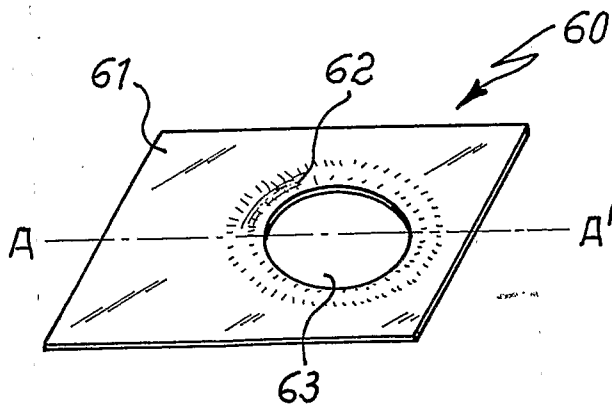


Fig. 2f

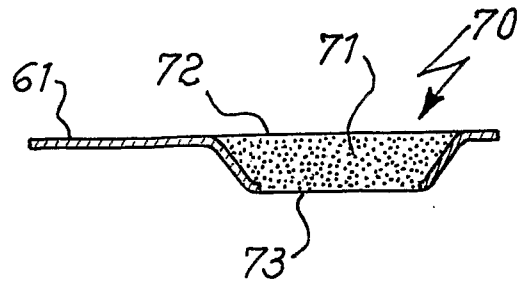
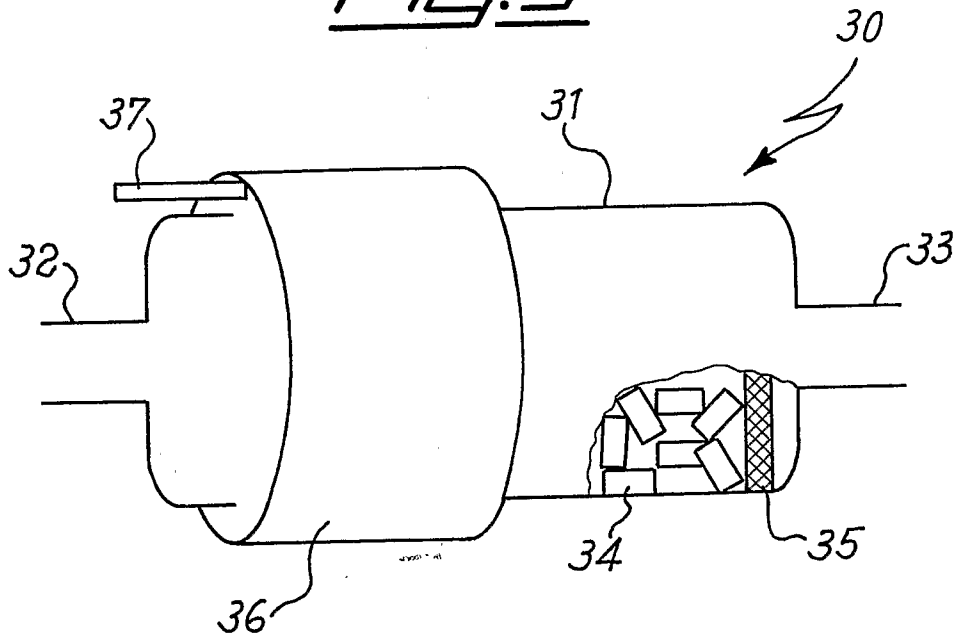


Fig. 3



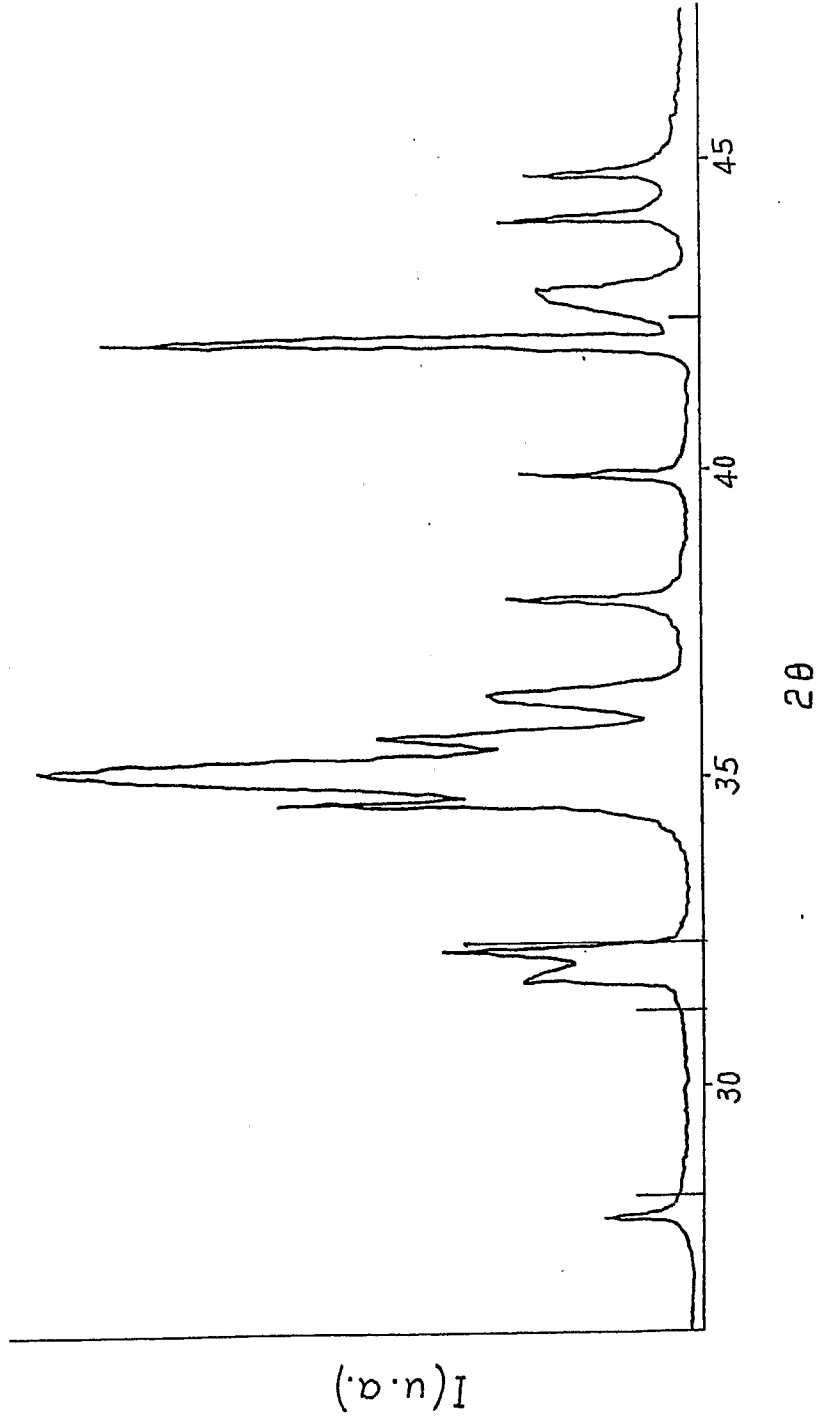


FIG. 4

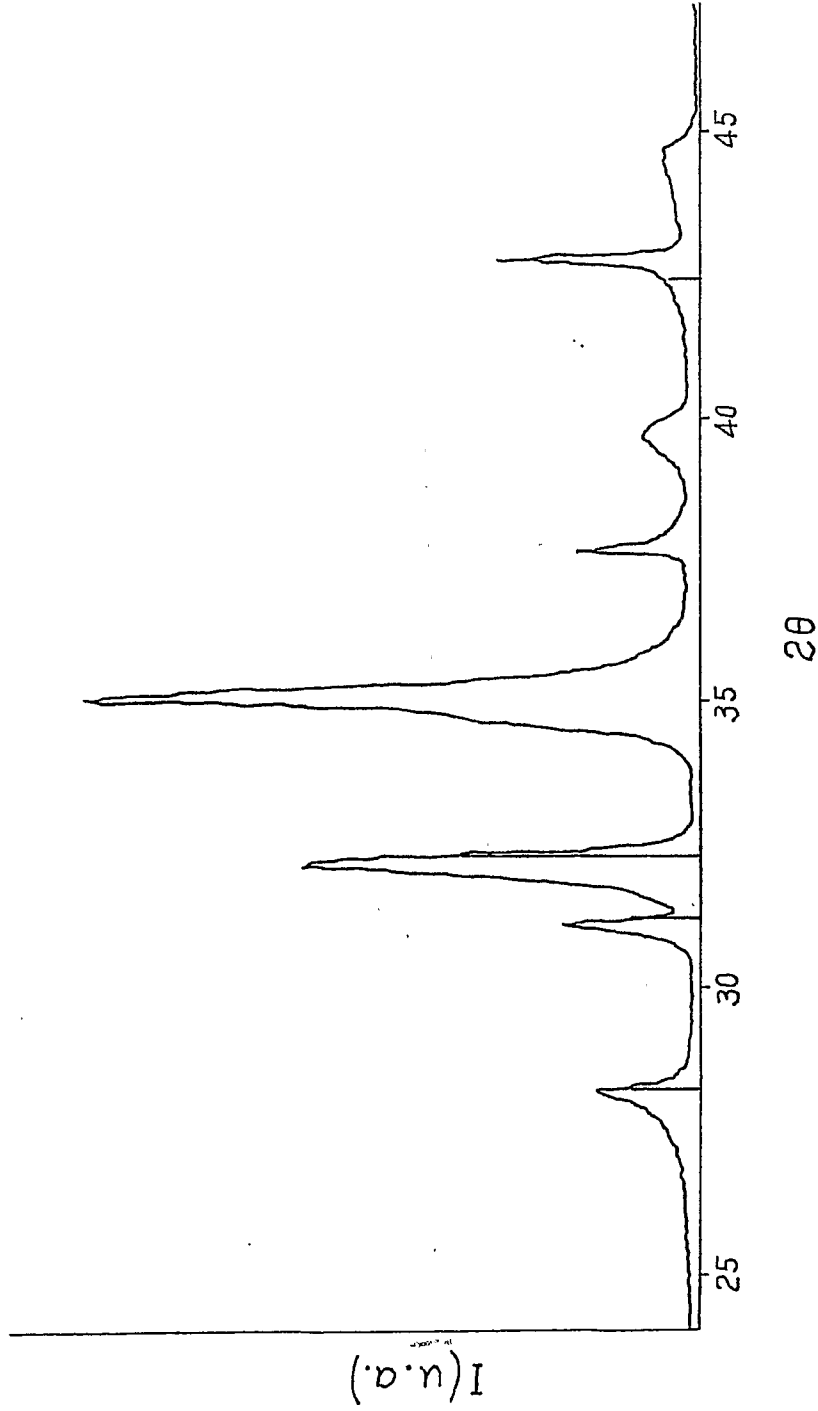


FIG. 5

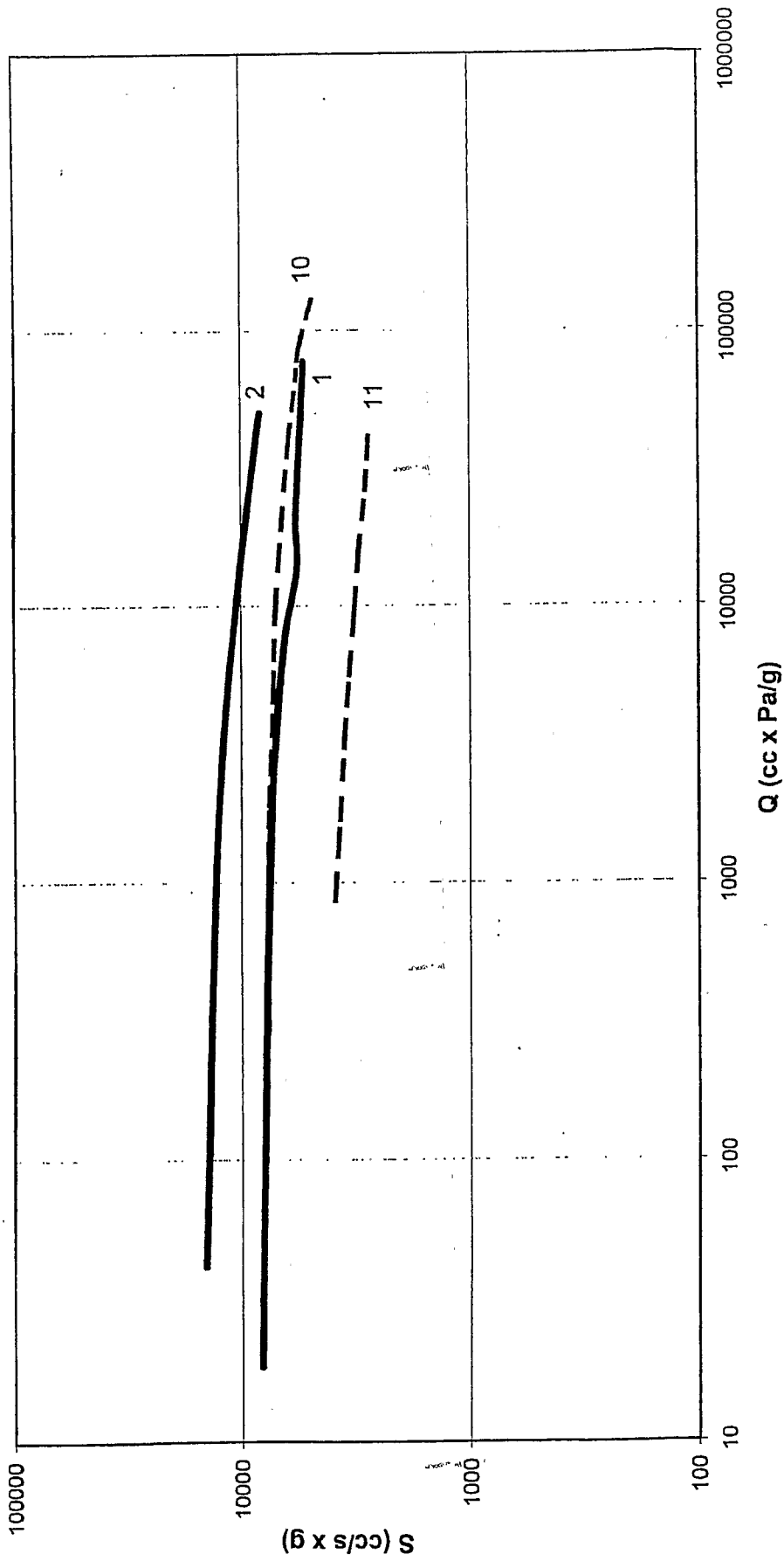


FIG. 6

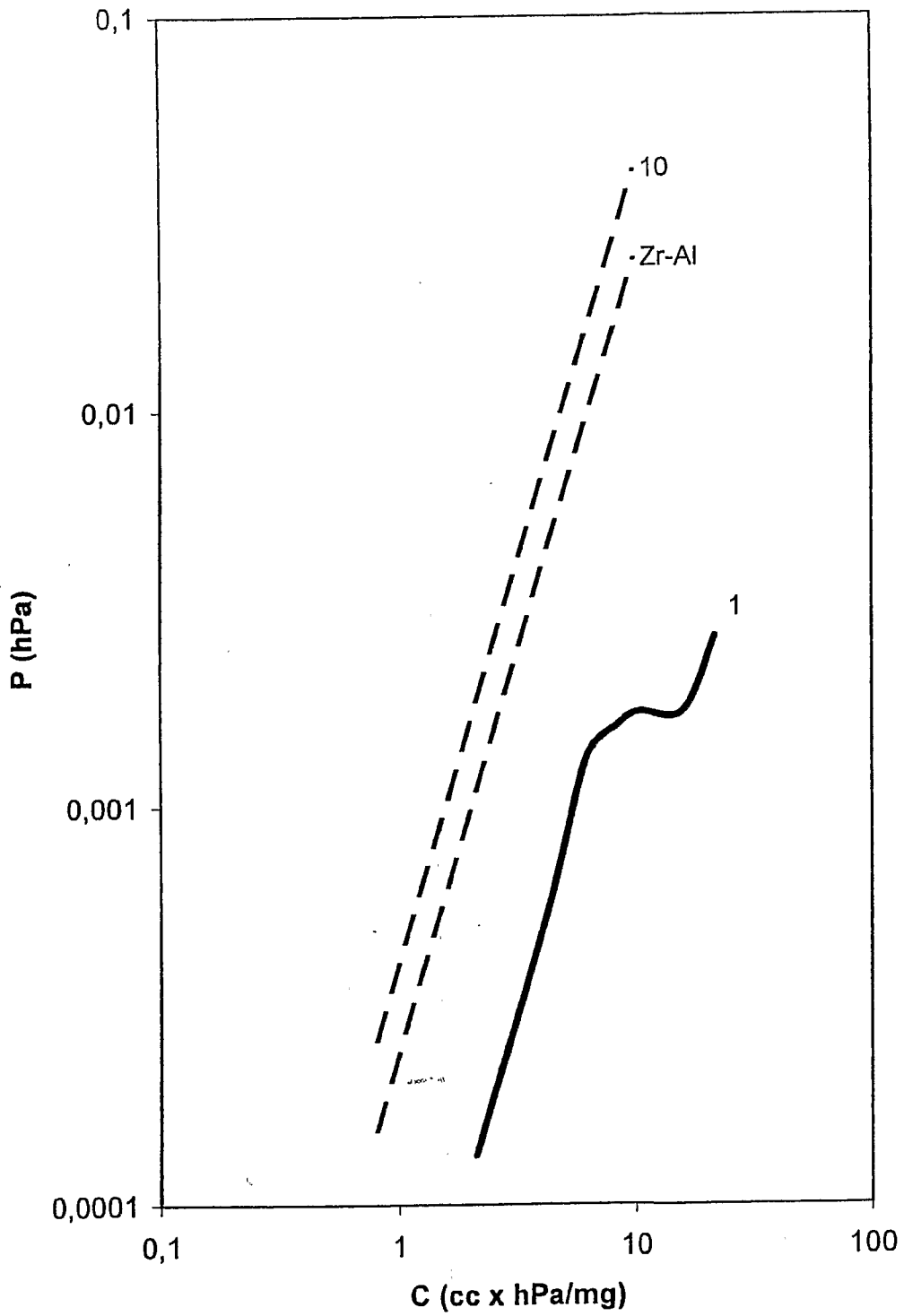


Fig. 7

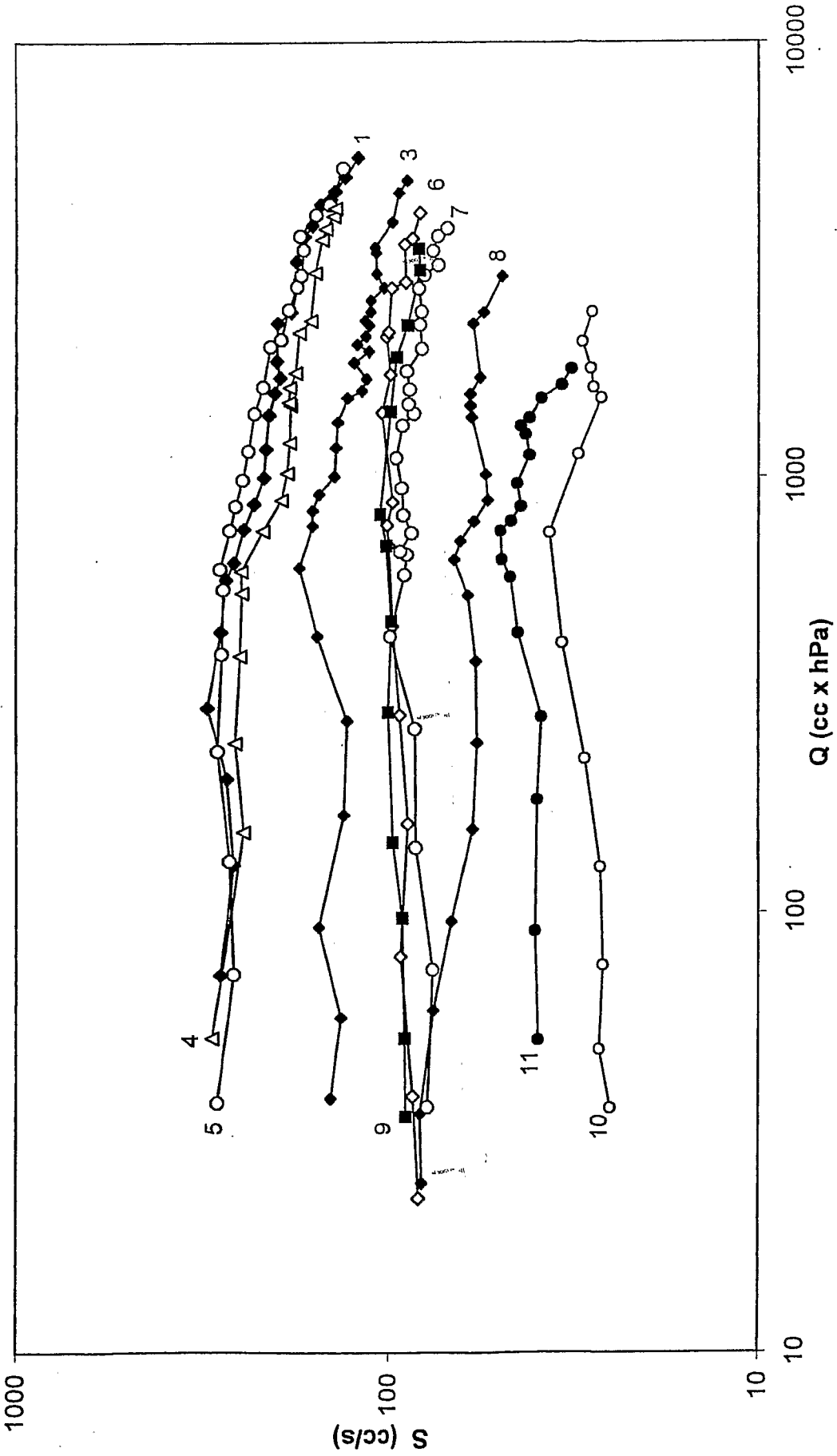


FIG. 8

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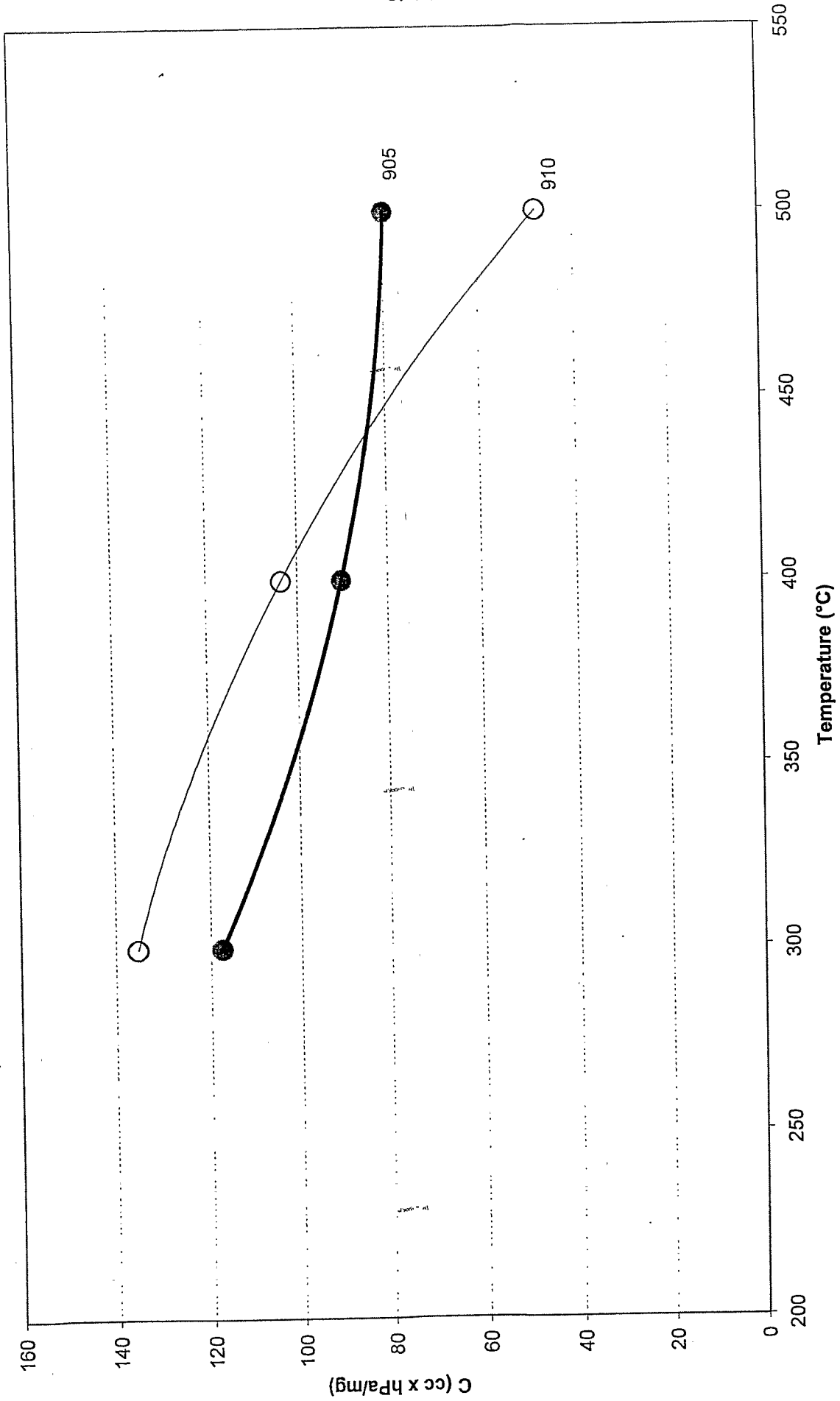


FIG. 9

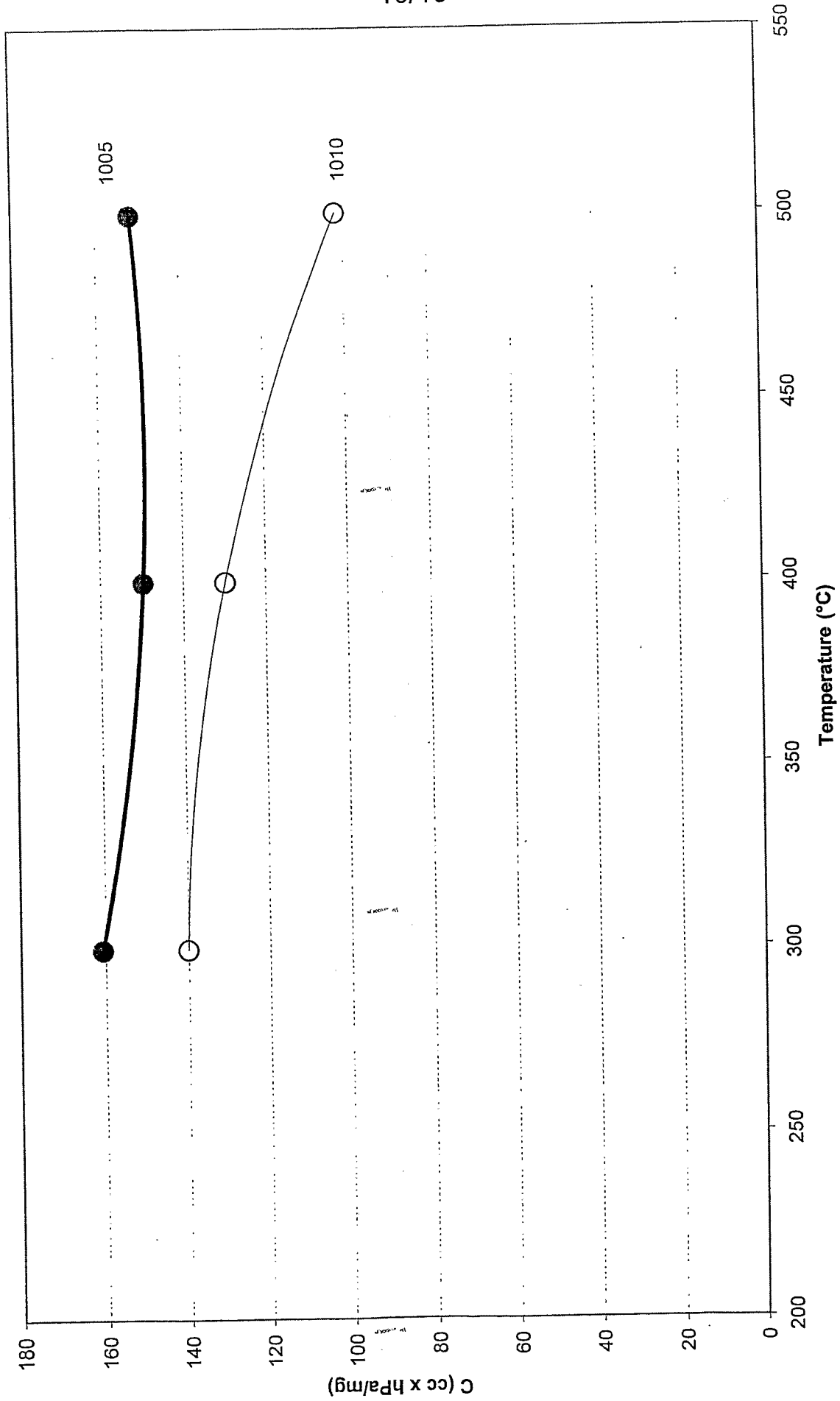


Fig. 10