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EUROPEAN QUALIFYING EXAMINATION 2026

PAPER A

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Client’s letter

Dear Mr Cook,

[001] Our company designs, produces and sells kitchen countertop appliances and cookware of all sorts throughout Europe. Our main market consists of frying pans, but we also sell a range of cooking pots, woks, pressure cookers, raclette kits, air fryers, waffle makers, baking trays, barbecue grills and plancha plates. All of the cookware we sell is provided with a cooking surface that has non-stick properties.

[002] The non-stick feature of the cooking surface of our cookware is of crucial importance for us. We have been using Teflon™ for the last few decades, as it has proven to be the most reliable non-scratch coating and the easiest to manufacture. However, despite the care taken by customers in using only non-abrasive cooking utensils on our cookware, we have found that scratches inevitably appear on the coated cooking surfaces at the latest after a couple of years of use, and this negatively affects their non-stick function.

[003] In recent years, we have also become aware of the serious effects of Teflon™ on consumer health and on the environment. Teflon™ emits toxic, potentially carcinogenic substances when heated at cooking temperatures. These effects are even more pronounced if the Teflon™ surface is scratched. Furthermore, Teflon™ has a very long half-life and therefore degrades extremely slowly in the environment. At the end of the cookware life cycle, the Teflon™ residues of these Teflon™-coated materials remain in the environment as “forever-chemicals”, with serious consequences for the ecosystems concerned.

[004] We therefore saw a need to develop cookware comprising a non-stick, scratch-resistant and non-toxic coated surface.

[005] We discovered that applying a sol-gel coating to the cooking surface instead of Teflon™ achieves particularly good non-stick properties, even better than Teflon™. Moreover, the scratch resistance and general durability are improved.

[006] The name sol-gel derives from the fact that micro-particles in a solution (sol) agglomerate and subsequently, using a gel component that starts the gelling process under controlled conditions, form a sol-gel composition that is then used for coating. All sol-gel compositions are inorganic compositions, which means they are part of a family of chemical compositions that do not contain carbon-carbon bonds. The inorganic sol-gel compositions used for coating our cooking surfaces have no adverse health effects and are non-toxic for the environment.

[007] The non-stick sol-gel coating is the result of a multi-step process. To obtain a reliable sol-gel coating, the process must comprise at least the steps of (a) providing a sol, (b) performing a gelation by adding a gel starter, and (c) performing a drying-densification. Once the sol is provided, a suitable starter is added, which results in the solution gelling; at this step, the sol-gel composition has reached a liquid, high-viscosity state and is ready to be applied to a substrate (21) to be coated; after application to the substrate, the sol-gel composition is dried and densified in an appropriate oven at temperatures above 250°C, so as to obtain the cooking surface with the final inorganic sol-gel coating (20), as can be seen in Figure 1a. During drying and densification at more than 250°C, the organic part of the initial components decomposes, forming a hard inorganic layer. The organic part of the initial components is consequently no longer present in the final product. This fact makes us wonder whether we could also file for protection of our products as such, as product protection is essential for our business.

[008] The sols used in the composition can be any of the known organic precursors usually involved in a sol-gel process. Examples of the ones we use include TEOS (tetraethylorthosilicate), MTES (methyltriethoxysilane), GPTMS (3-glycidyloxypropyltrimethoxysilane), MPTMS (3-mercaptopropyltrimethoxysilane) but we have also used other precursors.

[009] Among the substances capable of launching the gelling process, we found that any of the known organic gel starters is capable of obtaining a reliable sol-gel coating for our cooking surfaces. However, we obtained the best results in terms of durability when using citric acid, ethanol, lactic acid or oxalic acid as gel starters.

[010] We tried numerous variations of sol-gel coatings. They were obtained by considering different combinations of precursors and gel starters, which are however always in a ratio by weight of between 1:1 and 6:1 of sol precursor to gel starter. Indeed, we found that, when the ratio is outside this range, the corresponding sol-gel coating does not properly form. This is therefore the only manufacturable ratio range for a sol-gel coating with such starters. All the coatings that we prepared have good non-stick properties and are scratch resistant and safe to use in contact with food. However, we achieved by far our best results with sol-gel compositions obtained from a combination of TEOS as a precursor and citric acid as a gel starter. Indeed, the resulting inorganic sol-gel coating achieves optimal hardness, as shown in Table 1 below, and this hardness is a reliable indication of the resistance to the typical scratches that occur with cooking utensils. The hardness was measured according to the known ISO 14705 norm of 31.12.2016 over the whole manufacturable ratio range.

Table 1

Sol-gel combination	Hardness	Ratio
MPTMS & ethanol	4 - 5	1:1 - 6:1
MTES & lactic acid	5.5 - 7	1:1 - 6:1
TEOS & oxalic acid	6 - 6.5	1:1 - 6:1
MTES & ethanol	6 - 11	1:1 - 6:1
TEOS & citric acid	12 - 15	1:1 - 6:1

[011] Our best results in terms of scratch resistance and non-stick properties came with a ratio by weight of 4:1 of TEOS to citric acid. This sol-gel composition has a hardness of 15. We named it TEOSCA41.

[012] All our cookware, such as the pan (10) shown in the figures, has a metal substrate, which is necessary for the cooking surface to warm up efficiently. We like to use aluminium for the substrate whenever possible, as this makes the cookware lighter, and improves the adherence of the sol-gel coating.

[013] We also tested the use of two metal layers for the substrate, with aluminium, to which the coating is applied, as an upper layer (21) and another metal, such as stainless steel or iron, as a lower layer (22) underneath the aluminium, as you can see in Figure 1b. We are satisfied with the test results, as a cookware item of this kind achieves both very good thermal conductivity and good adherence of the sol-gel coating to the cooking surface.

[014] In order to apply our sol-gel composition to the substrate, we like to use an automatic spraying machine, such as the one in Figure 2. The sprayer (30) is automatically controlled by a control system to move within the geometrical boundaries of the cooking surface and to apply the sol-gel coating to the substrate of the whole cooking surface. The system comprises an electronic controller to control the movement of the sprayer and a memory that stores two-dimensional spraying patterns corresponding to the external dimensions of the cooking surfaces to be treated, thereby minimising the amount of sol-gel sprayed beyond the cooking surface and wasted. The electronic controller then selects the two-dimensional pattern corresponding to the cooking surface to be treated and operates the sprayer based on this pattern. The moving speed of the sprayer can be adapted to apply the coating efficiently to the substrate and thereby also optimise the production costs. We tested several application speeds and found that moving speeds between 0.1 and 0.8 m/s correspond to our needs.

[015] As said above, we not only sell cookware with a horizontal cooking surface, but also other items which may have non-horizontal cooking surfaces, such as curved areas and corners occurring, for example, in larger pots, ridged plancha plates or waffle makers. A horizontal cooking surface is a surface that is horizontal during the cooking process. When applying the sol-gel composition to an item of this cookware, the electronic controller of our spraying machine is configured to firstly apply the sol-gel composition to all the horizontal cooking surfaces of the item by getting the sprayer to spray the sol-gel composition orthogonally to the horizontal plane of the cooking surface. The sol-gel composition is subsequently applied to all the non-horizontal cooking surfaces by maintaining the sprayer of our machine in a position that allows it to spray horizontally and then moving it to cover all inclined or vertical parts with the coating. In this case, the sprayer only needs two angles of application during use, one allowing for vertical application in a first step and another allowing for horizontal application in a second step. We found that the range of moving speeds of the sprayer between 0.1 and 0.8 m/s is still perfect for both spraying steps.

[016] We also applied two sol-gel coatings, each a combination of TEOS and citric acid but in different ratios in either case, to the same item of cookware. One of the coatings was TEOSCA41, which we only applied to the horizontal cooking surface (20b), as shown in Figure 1c. The other coating was a combination of TEOS and citric acid in a ratio by weight of 2:1. This latter sol-gel composition has non-stick properties which are good enough for the parts (20a) of the cooking surface which are inclined or vertical during use, such as the walls of a deeper pot or the interstices of a waffle maker, as gravity also contributes to lowering the adherence of food to the surface of these areas. Such two-step application minimises the material costs while still ensuring very good non-stick properties.

[017] When applying two different sol-gel coatings to cookware items, the electronic controller of our spraying machine is firstly configured to apply the first sol-gel composition, TEOSCA41, to all the horizontal surfaces of the items by spraying the first sol-gel mixture orthogonally to the horizontal plane of the cooking surfaces, as described above. The second sol-gel composition is subsequently applied to all the non-horizontal cooking surfaces of all the items by maintaining the sprayer of our machine in such a way as to spray the second sol-gel mixture horizontally and moving the sprayer to cover all inclined or vertical parts with the coating.

[018] As of this afternoon we will be sailing to Corsica in an exclusively wind-powered trimaran. The crossing is expected to last until tomorrow morning and we will have no internet or telephone coverage during this time. We are scheduled to present our new sol-gel cookware first thing tomorrow morning upon arrival in Corsica at the largest kitchenware fair in Europe. We are therefore counting on your expertise and efficiency to file, before the end of the day, a European patent application that can give us the broadest protection possible using the information we have provided here, which we trust to be complete. We have also attached D1 and D2 to this letter, which are the most relevant prior art documents that we have found. We would also like to remind you that in accordance with our company’s policy we wish to file a single application and that we have no budget for additional claim fees.

Warm regards,

Soline Gelsemium
R&D Department
SeBastian is in the Kitchen Ltd

Drawings

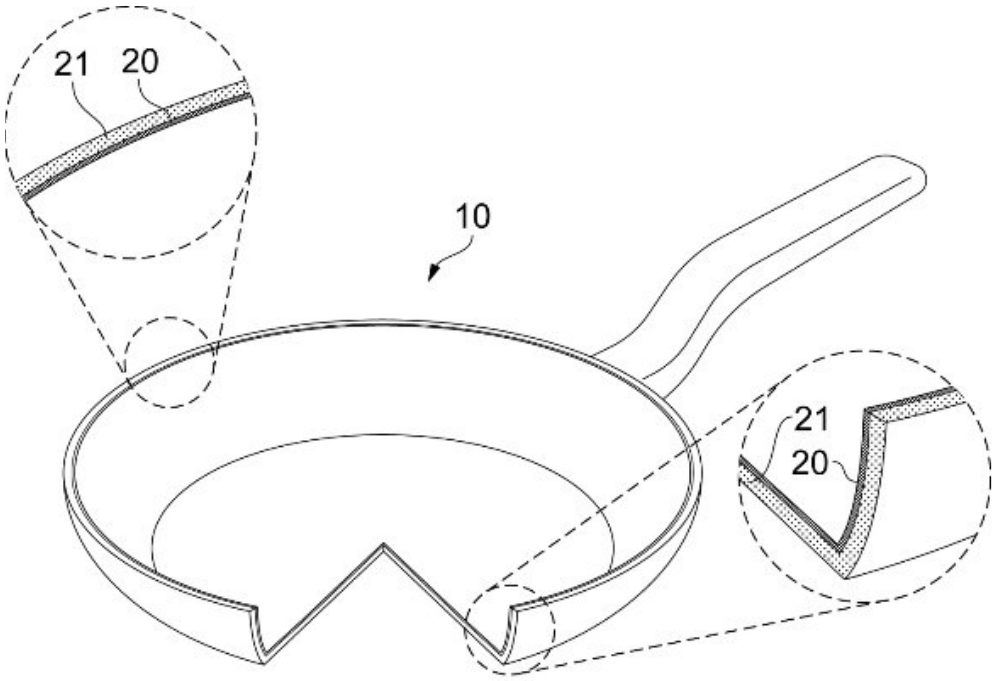

FIG. 1a

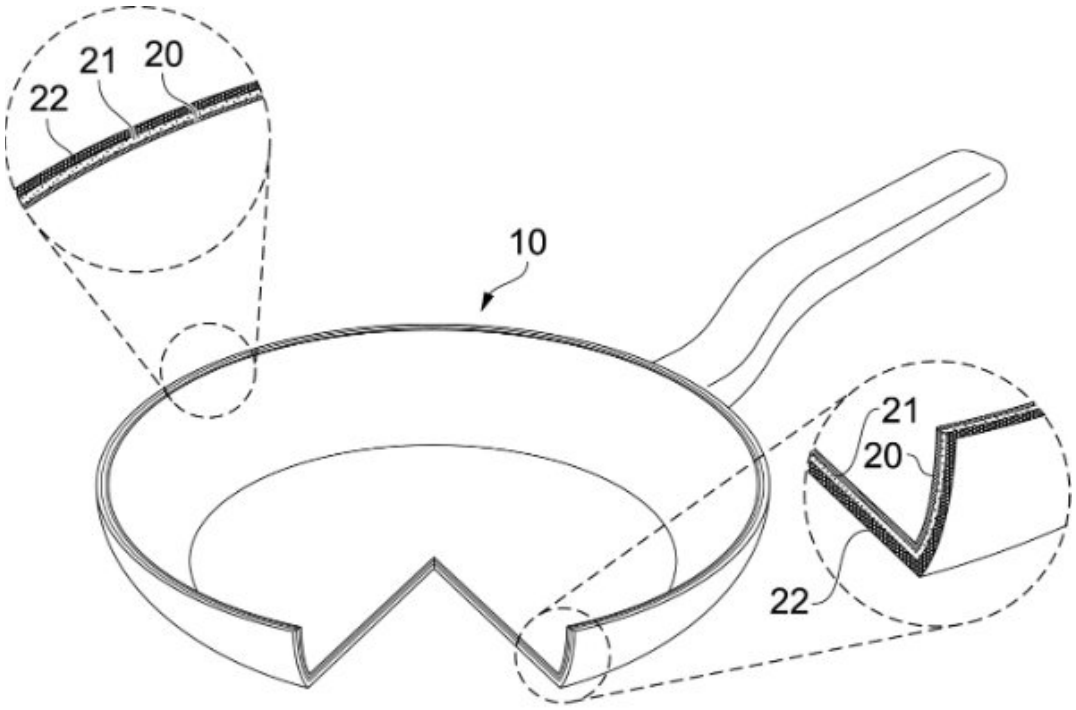

FIG. 1b

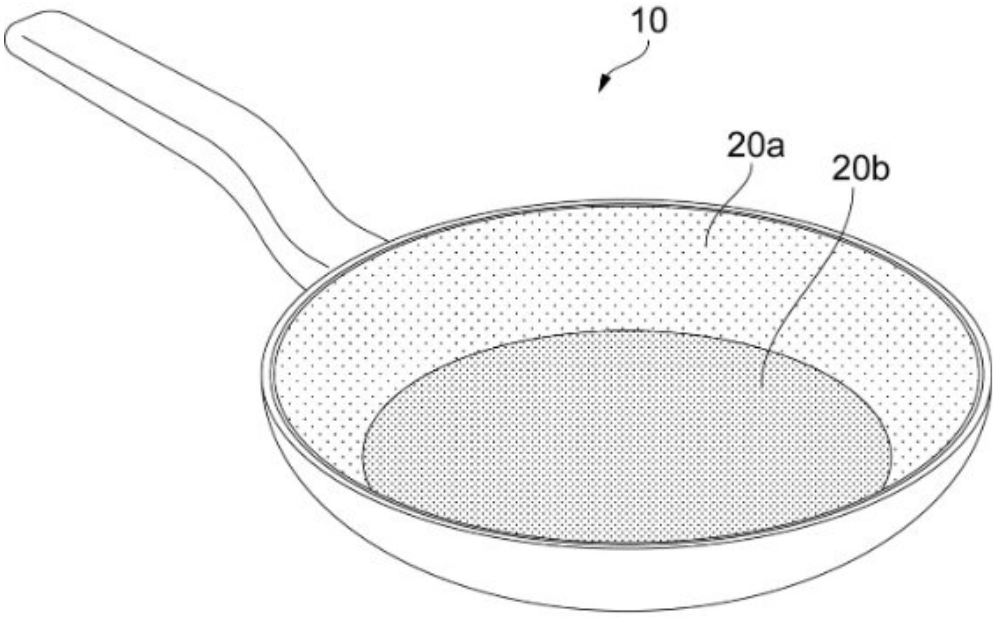

FIG. 1c

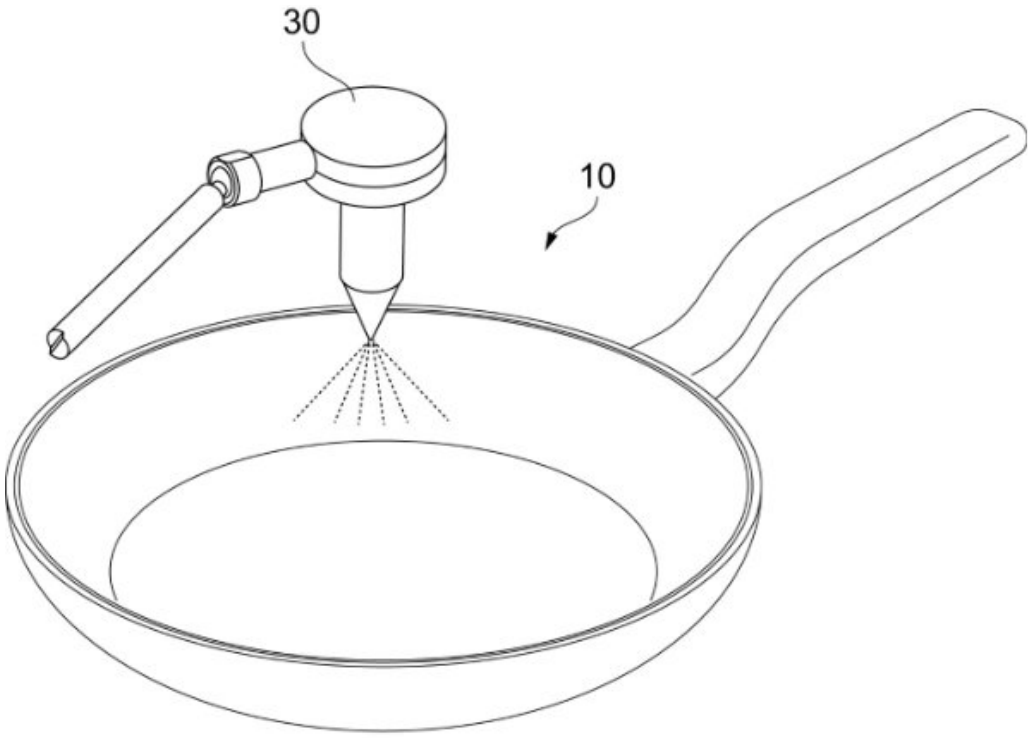

FIG. 2

D1: EP06180111

Applicant: Teffe-Loan GmbH
Filed 19.03.2006
Published 2007

Title: Cooking surface with improved non-stick coating

[001] Frying and baking has traditionally been practised in pans made of metal such as cast-iron or stainless steel. Although cast-iron pans are non-stick to some degree, they are extremely difficult and time-consuming to produce and maintain. As for stainless steel pans, the use of grease to prevent food from sticking to the pan is indispensable and exposes users to health risks associated with increased blood cholesterol.

[002] There is a tradition in certain cultures of making ceramic pots and pans by hand. For such cookware, a protective coating of a known sol-gel is usually applied. Although this ceramic-coated cookware has non-stick properties and is scratch-resistant, it is expensive and time-consuming to produce.

[003] We have developed Teflon™-coated metal cookware, which we have found to have better scratch resistance. They are easy and cheap to manufacture and have relatively low toxicity.

[004] We have also discovered that it is possible to make our newly developed coated cookware using two metal layers, with aluminium above for better adherence of the non-stick coating and stainless steel or iron beneath for better heat conductivity.

D2: International Journal of Material Science, No. 1903, July-September 2021
Sol-gel compositions for metal treatment

[001] Sol-gel coatings of metal surfaces have been successfully used in recent years in aeronautics and aerospace. Their anti-corrosion and liquid repellent properties together with their excellent hardness and scratch resistance in extreme weather conditions make them the ideal protective layer for the great diversity of metal surfaces used in such industries.

[002] The sol-gel coatings that have been studied here start with a sol precursor – such as TEOS (tetraethylorthosilicate), MTES (methyltriethoxysilane), GPTMS (3-glycidyloxypropyltrimethoxysilane) or MPTMS (3-mercaptopropyltrimethoxysilane) – to which a gel starter, which can be citric acid, ethanol, lactic acid or oxalic acid, is added to launch the gelation process. We usually use a ratio by weight of 1:1-6:1 sol precursor to gel starter, as we noticed that the sol-gel coatings do not form well outside this range.

Firstly, the sol precursor is added during a hydrolysis step. Then comes the gelation with the help of the gel starter, and subsequently a drying-densification takes place in ovens at high temperatures, preferably above 250°C.

[003] Right after the gelation and before the drying, the sol-gel composition is applied to the metal substrate using a special automatic spraying device that can move at speeds of up to 1.9 m/s. The spraying device is controlled by a control system to achieve an efficient application of the sol-gel composition. Its speed may be lowered to about 1.5 m/s to cover more complex surface areas. Its angle of application may be changed by the control system upon detection by an optical sensor of a change in inclination of the surface to efficiently cover areas that are inclined or more difficult to access. Geometrical spraying patterns corresponding to the boundaries of the surface to be coated can be stored in a memory, which the electronic controller of the control system can access to retrieve the appropriate pattern for the surface that will be treated. In this way, the unintended application of sol-gel composition beyond the surface to be treated is kept to a minimum.

[004] Adherence is best when the sol-gel coating is directly applied on the preferred substrate, which is made exclusively of aluminium.

[005] Such coated metal surfaces have proven to be an excellent alternative to Teflon™, fulfilling the high quality standards that the aeronautics and aerospace industries require. Teflon™ is still widely used in these industries but is toxic for the environment.

[006] The sol-gel coatings also have food contact standard, so they can also be used for cookware such as pans, pots or any other food container. The liquid repellent properties of the sol-gel coatings described above have been found to translate into non-stick properties when in contact with food items at the usual cooking temperatures.

[007] We are confident that such sol-gel coatings will find broader uses outside the aeronautics and aerospace industries in the coming years, as they have excellent anti-scratch and repellent properties while being non-toxic and environmentally friendly.

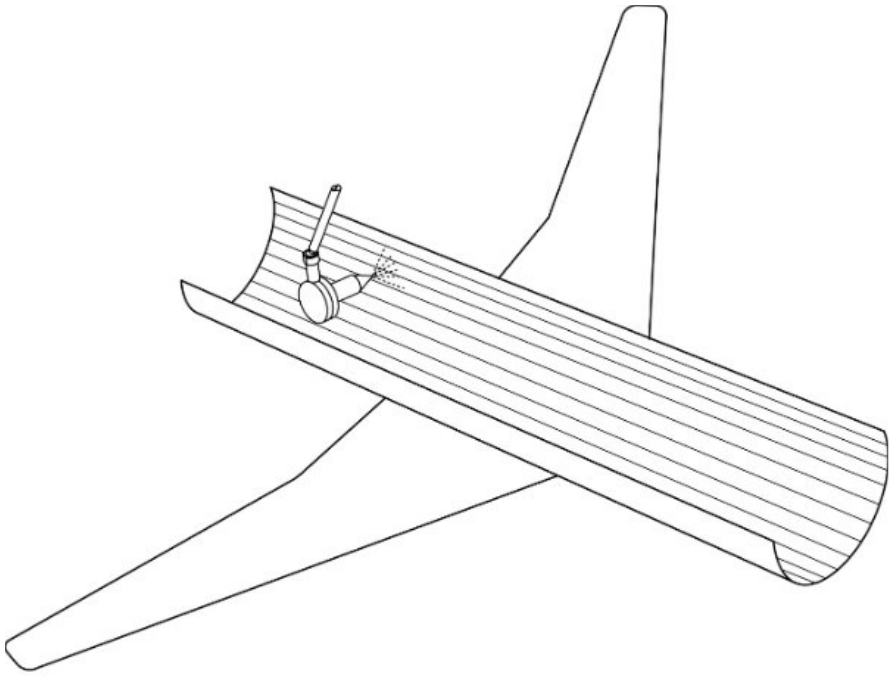

FIG. D2