The opinion in support of the decision being entered today
is *not* binding precedent of the Board.

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte LAWRENCE W. HRUBESH

Appeal No. 2007-1938
Application No. 10/050,437[1]
Technology Center 1700

Decided: August 10, 2007

Before RICHARD TORCZON, CAROL A. SPIEGEL and
MARK NAGUMO, *Administrative Patent Judges*.

SPIEGEL, *Administrative Patent Judge*.

DECISION ON APPEAL

I. Introduction

Lawrence W. Hrubesh (hereinafter "Appellant") seeks our review under 35 U.S.C. § 134 of the Examiner's final rejection of claims 1, 4, 8 and

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[1] The application on appeal was filed 15 January 2002. The real parties-in-interest are said to be the Regents of the University of California and the United States of America as represented by the United States Department of Energy.

18, all of the claims pending in this application. We have jurisdiction under 35 U.S.C. § 6(b). We AFFIRM.

The claimed subject matter relates to a method for producing a carbon aerogel composite. Claim 1 is illustrative of the subject matter on appeal:

> 1. A method comprising:
>
> infiltrating a solution containing a plurality of carbon aerogel precursors into a pre-formed polymer foam, or fiber-mat,
>
> allowing said solution to gel such that it encapsulates at least part of the pre-formed polymer foam or fiber-mat to form a gelled composite,
>
> drying the gelled composite to form a dried composite such that the surface tensile forces are reduced, and
>
> pyrolyzing the dried composite wherein the preformed polymer foam or fiber-mat and the carbon aerogel decompose simultaneously such that they remain essentially in contact at their interfaces to form a monolithic glassy carbon material.

The Examiner has relied on the following references of record as evidence of unpatentability:

Kaschmitter	US 5,260,855	Nov. 9, 1993
Pekala	US 5,932,185	Aug. 3, 1999
Droege	US 5,945,084	Aug. 31, 1999

The Examiner has rejected claims 1 and 18 under 35 U.S.C. § 102(b) as anticipated by Droege; claims 4 and 8 under 35 U.S.C. § 103(a) as obvious over Droege; and, claims 1, 4, 8 and 18 as under 35 U.S.C. § 103(a)

as obvious over Pekala in view of Kaschmitter (Answer[2] 2). Kaschmitter, Pekala and Droege qualify as prior art under 35 U.S.C. § 102(b).

Appellant relies on the following documents of record as evidence of patentability:

Declaration under 37 CFR § 1.132 of Lawrence W. Hrubesh dated 19 January 2005 ("the Hrubesh Declaration")

Lu et al. ("Lu"), "Thermal and electrical conductivity of monolithic carbon aerogels," *J. Appl. Phys.*, vol. 73, no. 2, pp. 581-584 (15 January 1993)

Tajiri et al. ("Tajiri"), "Effects of supercritical drying media on structure and properties of silica aerogel," *J. Non-Crystalline Solids*, Vol. 186, pp. 83-87 (1995).

Since Appellate has indicated that all the claims stand or fall together (Br. at 4), we decide this appeal on the basis of claim 1. 37 CFR § 41.37(c)(1)(v).

II. Findings of Fact ("FF")

The following findings of fact are supported by a preponderance of the evidence of record. To the extent any "finding of fact" is a conclusion of law, it should be so treated.

A. Appellant's specification

[1] Aerogels are said to be fragile materials (Specification ¶ 3).

[2] A composite of an organic aerogel and a reticulated vitreous carbon ("RVC") is said to combine the optical, thermal, acoustic, and

[2] We refer to the Supplemental Examiner's Answer ("Answer") mailed 16 November 2006 in response to the Corrected Brief on Appeal ("Br.") filed 23 October 2006.

electrical properties of an aerogel with the strength of an RVC (Specification ¶ 4).

[3] According to the specification, "[t]he structure of the final carbon product of this invention consists of a matrix of porous carbon aerogel, reinforced by solid carbon struts, all in intimate contact so that the strength of the composite is maximized" (Specification ¶ 11).

[4] Further according to the specification, the composite is made by

> infiltration of an organic gel precursor into a pre-formed organic polymer foam, where it gels. The gel composite is then dried by any method that minimizes shrinkage of composite material. Whereafter, the dried gel composite is heated in a furnace to pyrolyze the composite, reducing it to a glassy carbon form. [Specification ¶ 11.]

[5] The organic gel precursor may be an aqueous solution comprising resorcinol, formaldehyde and sodium carbonate (Specification ¶ 14).

[6] The organic polymer foam may comprise a phenol-formaldehyde resin (Specification ¶ 14).

[7] Gelling may occur at a 80°C for 30 to 180 minutes (Specification ¶ 14).

[8] Drying may occur by evaporation for 12 to 48 hours or by supercritical drying after fluid exchange with liquid carbon dioxide (Specification ¶ 14)

[9] Pyrolyis may be at a temperature of 700 to 1100°C for 8 to 12 hours (Specification ¶ 14).

[10] Pyrolysis is said to simultaneously decompose both the organic polymers "so that the shrinkage of each occurs in a manner that

essentially maintains contact of the polymers at their interface" (Specification ¶¶ 13 and 16).

[11] The specification does not define the claim term "monolithic."

[12] Table 1 is said to show data for composites of carbon aerogel and (a) phenolic resin foam, (b) resorcinol resin foam and (c) furan foam (Specification 6:1).

[13] Table 1 does not show any porosity data for the three carbon aerosol-foam composites which are said to have densities of (a) 125, (b) 124 and (c) 115 kg/m^3, respectively (Specification 6, Table 1).

B. Droege

[14] Droege describes a method of forming an aerogel/carbon substrate composite comprising infusing a porous carbon substrate with a mixture of carbon aerogel precurors, allowing the infused porous carbon substrate to form a gel/porous substrate composite, curing the gel/porous substrate composite, drying the cured gel/carbon substrate composite and pyrolyzing the dried gel/carbon substrate composite (Droege col. 2, ll. 15-20; col. 7, ll. 18-20; col. 14, ll. 15-65).

[15] The carbon aerogel precursors comprise an aqueous solution of resorcinol ("R"), formaldehyde and a sodium carbonate catalyst ("C") having a molar concentration R/C value of greater than about 1000 (Droege col. 4, ll. 24-30; col. 5, ll. 1-5; col. 6, l. 65 - col. 7, l. 5; col. 14, ll. 25-31).

[16] The porous carbon substrate may take a variety of forms, including fibers and reticulated foams (Droege col. 14, ll. 49-65).

[17] Droege describes typical gelation temperatures from about 20 to about 70°C and typical gelation times from about 0.1 to about 24 hours (Droege col. 9, ll. 50-51 and 56-57).

[18] Droege describes typical curing temperatures from about 50 to about 95°C and typical curing times from about 3 to about 72 hours (Droege col. 10, ll. 17-18 and 23-24).

[19] Conventional drying methods, including supercritical evaporation using carbon dioxide exchange, may be used (Droege col. 10, l. 65-col. 11, l. 6 and col. 11, ll. 27-45).

[20] Droege describes typical pyrolysis temperatures from about 600 to 3000° C, e.g., from about 800 to about 1150° C, and typical pyrolysis times from about 1 to about 6 hours (Droege col. 13, ll. 22-25 and 29-30).

[21] According to Droege, pyrolysis temperature varies with pyrolysis time and the composition and amount of aerogel (Droege col. 13, ll. 19-22).

[22] According to Droege, its aerogels are characterized by meso-pore size distributions including embodiments from about 5 to about 50 nm, from about 7 to about 50 nm, from about 10 to about 50 nm, and from about 10 to about 25 nm (Droege col. 11, ll. 54-65).

[23] For example, processing aerogels prepared with a solids content of greater than R=50% w/v yield gels with pore sizes not larger than about 100 nm (Droege col. 12, ll. 19-30).

[24] Example 3 of Droege is said to describe formation of an aerogel/carbon fiber substrate composite having a pore size

distribution of 20 nm and a density of 419 kg/m^3 (Droege col. 16, l. 40 - col. 17, l. 7, esp. col. 17, ll. 3-4, and col. 19, l. 15).

[25] The Examiner found that Droege taught a method comprising (i) forming a reaction mixture containing a plurality of carbon aerogel precursors, e.g., resorcinol and formaldehyde, (ii) infiltrating a porous carbon or organic substrate in the form of a foam, fiber, etc., with the reaction mixture, (iii) heating at a gelation temperature to gel the reaction mixture, (iv) heating the composite at a curing temperature to cure the gel, (v) drying the composite and (vi) pyrolyzing the composite to carbonize (Answer 2; Rejection[3] 3).

[26] The Examiner found that Droege taught drying by conventional methods, including supercritical evaporation using supercritical carbon dioxide (Answer 2; Rejection 3).

[27] The Examiner construed the claim term "monolithic" as meaning "a uniform whole" (Answer 3).

[28] Thus, the Examiner found claims 1 and 18 anticipated by Droege (Answer 2).

[29] The Examiner also found that gelation and pyrolysis times and temperatures were result effective variables (Answer 2; Rejection 4).

[30] The Examiner concluded that it would have been obvious to one of ordinary skill in the art to use a gelation temperature slightly higher than the 20 to 70° C range taught by Droege, e.g., 80° C as recited in claim 4, in order to allow for a shorter gelation time (Answer 2; Rejection 4).

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[3] We refer to the Office action mailed 20 July 2004 ("Rejection") cited in the Answer.

[31] The Examiner further concluded that it would have been obvious to one of ordinary skill in the art to use a pyrolysis time longer than the typical 1 to 6 hours taught by Droege, e.g., 8 to 12 hours as recited in claim 8, to ensure that pyrolysis and carbonization is fully achieved (Answer 2; Rejection 4).

[32] Appellant argues that Droege fails to teach a drying step which adequately reduces surface tensile forces to produce a monolithic composite or how to form an essentially monolithic composite when pyrolyzed (Br. 4).

[33] Appellant relies on the Hrubresh Declaration in support of his position (Br. 4).

C. The Hrubesh Declaration

[34] Lawrence W. Hrubesh, Ph.D., is the named inventor of the application on appeal (Hrubesh Declaration at 1-2).

[35] Dr. Hrubesh testified that "monolithic glassy carbon composites of the present invention have average pore sizes that are less than 100 nm" because monolithic aerogels of comparable densities have average pore sizes less than 100 nm as confirmed by Lu (Hrubesh Declaration at 2).

[36] Dr. Hrubesh further testified that "typical pore sizes for supercritically dried aerogels are less than 10 nm" as shown by Tajiri (Hrubesh Declaration at 2).

[37] The Examiner found that the Hrubesh Declaration is not commensurate in scope with the claims because it appears to require particular drying conditions, whereas the claims are not so limited "so long as surface tensile forces are reduced" (Answer 3).

D. Lu

[38] According to Lu, **SiO_2** aerogels with densities of about 150 kg/m^3 have pore sizes < 100 nm (Lu 581, col. 1, ¶ 1).

E. Tajiri

[39] Tajiri discussed the effects of supercritical drying media on the structure and properties of **silica** aerogels and "concluded that the supercritical drying medium affects the aerogel structure" (Tajiri 86, col. 2, ¶ 2).

[40] According to Tajiri, pore sizes less than 10 nm were obtained with methanol and 2-propanol-dried aerogels (Tajiri 85, col. 2, ¶ 1).

[41] Table 1 of Tajiri lists specific critical temperature and pressure parameters for methanol, ethanol, 2-propanol and carbon dioxide drying medium (Tajiri 84).

Other findings of fact follow below.

III. Anticipation and Obviousness Rejections Based on Droege

Anticipation requires disclosure of each and every claim limitation in a single prior art reference, either explicitly or inherently. *MEHL/Biophile Int'l Corp. v. Milgraum*, 192 F.3d 1362, 1365, 52 USPQ2d 1303, 1305 (Fed. Cir. 1999). It is well settled that "anticipation is the epitome of obviousness." *Cornell v. Sears Roebuck & Co.*, 722 F.2d 1542, 1548, 220 USPQ 193, 198 (Fed. Cir. 1983) (quoting *In re Fracalossi*, 681 F.2d 792, 794, 215 USPQ 569, 571 (CCPA 1982)).

The Examiner found that Droege teaches the same method of forming an aerogel/carbon substrate composite as claimed by Appellant (Answer 2; Rejection 3-4). The Examiner also found "[i]t is expected that any method of drying will reduce the surface tensile forces to some degree" (Answer 3).

Appellant argues, as to claim 1, that Droege "teaches a drying method that does not reduce surface tensile forces adequately to produce a monolithic composite" and "does not teach how to produce an essentially monolithic foam/mat aerogel composite" (Br. 4). Appellant relies on the definition of a monolithic composite provided by Dr. Hrubesh in his Declaration (Br. 4). Dr. Hrubesh testified that his inventive monolithic glassy **carbon** composites have average pore sizes less than 100 nm (FF 35). Dr. Hrubesh based his opinion on typical pore sizes found in **silica** aerogels of the prior art said to have "comparable densities" or prepared by "supercritical drying" (FF 35 and FF 36). In essence, Appellant relies on an "inverse" product-by-process argument which contends that the claimed process produces a "monolithic" glassy carbon aerogel composite having an average pore size less than 100 nm, whereas the Droege process does not.

First, Appellant's specification does not define the claim term "monolithic" used to characterize the product produced by the claimed method or provide any porosity data for the three carbon aerosol foam composites discussed in its Table 1 (FF 11 and FF 13). The Examiner has construed the claim term "monolithic" as meaning "a uniform whole" (FF 27). During examination of a patent application, claims are given their broadest reasonable construction consistent with the specification. *In re Zletz*, 893 F.2d 319, 320-21, 13 USPQ2d 1320, 1322 (Fed. Cir. 1989). “The reason is simply that during patent prosecution when claims can be amended, ambiguities should be recognized, scope and breadth of language explored, and clarification imposed.” *Id*. “An essential purpose during patent examination is to fashion claims that are precise, clear, correct, and unambiguous.” *Id.* 893 F.2d at 322, 13 USPQ2d at 1322. “Only in this way

can uncertainties of claim scope be removed, as much as possible, during the administrative process." *Id.* Appellant has not amended his claims to state clearly and unambiguously that the recited method steps produce a carbon aerogel composite having an average pore size of less than 100 nm. Nor has Appellant pointed to any evidence of record establishing that one of ordinary skill in the art would have understood a monolithic glassy carbon composite prepared by any method within the scope recited in the claims would necessarily have an average pore size of less than 100 nm.

Here, Droege describes the same method steps as recited in claim 1 and describes using the same materials and method steps as set forth in Appellant's specification (FF 28). Droege describes aerogels having pore sizes not larger than 100 nm (FF 23) and expressly exemplifies a carbon aerogel fiber composite having a pore size distribution of 20 nm and a density of 419 kg/m^3 (FF 24). Furthermore, the density of the carbon aerogel fiber composite of Droege Example 3 appears "comparable" to the ~ 150 kg/m^3 density of the silicon aerogels disclosed by Lu (FF 38) and the 115-125 kg/m^3 densities said to be attributed to the carbon aerogel foam composites shown in Table 1 of Appellant's specification (FF 13). Moreover, Appellant has not shown that the properties of a Droege carbon aerogel composite are not comparable to the properties of a carbon aerogel composite produced by the claimed method. *Compare In re Thorpe*, 777 F.2d 695, 697, 227 USPQ 964, 965-66 (Fed. Cir. 1985) (product-by-process patent properly denied where end result was indistinguishable from prior art). The Hrubesh Declaration does not provide measurements of the average pore size of a **carbon** aerogel composite produced by the claimed method or explained how the structure and properties of **silica** aerogels

relate to **carbon** aerogels and **carbon** aerogel composites. Thus, the weight of the evidence indicates that the Droege method produces a "monolithic glassy carbon" material composite. Appellant has not shown otherwise.

Appellant's argument that Droege "teaches a drying method that does not reduce surface tensile forces adequately to produce a monolithic composite" is also unpersuasive of Examiner error. Appellant has not explained what defines an "adequate" reduction in surface tensile forces, e.g., reduced vis-à-vis what standard reduction. Without a reasoned basis for comparing the drying step of claim 1 with the drying step of Droege, we find that the method of Droege meets the drying limitation of the claimed method. Moreover, since the method of Droege produces a monolithic glassy carbon material, e.g., a monolithic carbon aerogel composite having a pore size distribution less than 100 nm (FF 22-FF 24), it appears that Droege's method does satisfy the claim limitation of a drying step "such that the surface tensile forces are reduced." Appellant has not come forward with evidence to the contrary.

Therefore, based on the foregoing, we will affirm the rejections of claims 1 and 18 under § 102(b) and of claims 4 and 8 under § 103(a) over Droege.

IV. Obviousness Rejection Based on Pekala in view of Kaschmitter

A claimed invention is not patentable if its subject matter would have been obvious to a person of ordinary skill in the art. 35 U.S.C. § 103(a); *KSR Int'l Co. v. Teleflex, Inc.*, 127 S.Ct. 1727, 82 USPQ2d 1385 (2007); *Graham v. John Deere Co. of Kansas City*, 383 U.S. 1 (1966). Facts relevant to a determination of obviousness include (1) the scope and content of the prior art, (2) any differences between the claimed invention and the prior art, (3)

the level of ordinary skill in the art and (4) relevant objective evidence of nonobviousness. *KSR*, 127 S.Ct. at 1734, 82 SUPQ2d at 1389; *Graham*, 383 U.S. at 17-18.

A. Pekala

[42] Pekala discloses a method for producing thin carbon aerogel foam hybrid/composite electrodes comprising infiltrating a porous material, e.g., carbon papers, with a carbon foam (i.e., aerogel) precursor material which is subsequently cured and pyrolyzed at high temperatures, i.e., 500-3000° C, to form composite (Pekala col. 1, ll. 11-19; col. 2, ll. 18-26).

[43] The carbon foam precursor material may include an aqueous resorcinol, formaldehyde and sodium carbonate solution (Pekala col. 2, ll. 61-67; col. 3, l. 66 - col. 4, l. 3).

[44] Pekala describes drying using conventional techniques, e.g., supercritical drying using carbon dioxide (Pekala col. 4, ll. 21-23).

[45] Example 3 of Pekala is said to describe preparation of a carbon aerogel foam composite electrode having a density of ~ 600 kg/m^{-3} (Pekala col. 4, ll. 12-13).

[46] According to the Examiner, Pekala does not teach the hydroxylated benzene compound (e.g., resorcinol) to catalyst ratio required by the precursor solutions (Answer 2; Rejection 6).

B. Kaschmitter

[47] According to Kashmitter, the highest capacitance for carbon aerogel electrodes is said to be observed with an R/C value of 50 (Kashmitter col. 3, ll. 5-63, esp. at ll. 58-59).

[48] The Examiner concluded that it would have been obvious to one of ordinary skill in the art to use the a carbon aerogel precursor solution having an R/C value of 50 as disclosed by Kashmitter in the process of Pekala in order to obtain the highest capacitance from the produced electrode (Answer 2; Rejection 6).

[49] Appellant argues that the composites produced by Pekala and Kashmitter do not form monolithic foam/mat aerogel composites because the composites must have a relatively large average pore size to enable fluid transport therethrough (Br. 5).

[50] Appellant again relies on the Hrubesh Declaration for support (Br. 4).

[51] Dr. Hrubesh testified that both Pekala and Kaschmitter require a pore size large enough so that electrolyte fluid can flow through the electrode (Hrubesh Declaration 3).

[52] Dr. Hrubesh concludes that the large pore size of the composites produced by Pekala and Kaschmitter excludes the composites from being "monolithic" composites.

C. Discussion

The Examiner finds that Pekala teaches a method corresponding to the method of claims 1 and 18 and concluded that it would have been obvious to adjust parameters such as curing or pyrolysis times and temperatures to meet the limitations of dependent claims 4 and 8 (Answer 2; Rejection 5). The Examiner also maintains that it would have been obvious to use certain aerogel precursor reagent ratios as taught by Kaschmitter to obtain high capacitance from the carbon composite electrodes (Answer 2; Rejection 6).

Appellant only argues that the pore size of the carbon composite electrodes produced by the Pekala/Kaschmitter method must be larger than

100 nm for the electrodes to work (Br. 4-5; Hrubesh Declaration 4). Since, according to Appellant, monolithic foam/mat aerogel composites must have pore sizes less 100 nm, the method of Pekala/Kaschmitter cannot teach or suggest the claimed method (*id*.).

As discussed above, Appellant has failed to provide evidence sufficient to establish a pore size of less than 100 nm as a proxy definition of the "monolithic glassy carbon material" recited as the goal of the claimed method. Analogous to the above discussion, Appellant has failed to provide a sufficient basis from which to conclude that the Pekala/Kaschmitter method would not have been reasonably expected to produce a monolithic glassy carbon material given that Pekala/Kaschmitter teaches using the same materials and method steps. Moreover, Pekala teaches a carbon aerogel foam composite electrode having a density of ~ 600 kg/m^{-3} (FF 45) which appear comparable to the ~ 150 kg/m^3 density of the silicon aerogels disclosed by Lu (FF 38). In short, Appellant has not submitted evidence and arguments sufficient to rebut the *prima facie* case of obviousness set forth by the Examiner.

Therefore, based on the foregoing, we will affirm the rejection of claims 1, 4, 8 and 18 under § 103(a) as obvious over Pekala in view of Kaschmitter.

CONCLUSION

In summary, the decision of the Examiner to reject (i) claims 1 and 18 under 35 U.S.C. § 102(b) as anticipated by Droege; (ii) claims 4 and 8 under 35 U.S.C. § 103(a) as obvious over Droege; and, (iii) claims 1, 4, 8 and 18 as under 35 U.S.C. § 103(a) as obvious over Pekala in view of Kaschmitter is affirmed.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 CFR § 1.136(a).

AFFIRMED

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