

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

AMBILIGHT INC
Petitioner,

v.

LANNRAY OPTOELECTRONICS (ZHENJIANG) CO. LTD.
Patent Owner.

Case IPR2026-00367
U.S. Patent No. 10,539,851

**PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 10,539,851**

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35 U.S.C. §103	1, 2, 16

LIST OF EXHIBITS

Exhibit No.	Description
EX1001	U.S. Patent No. 10,539,851 (“the ’851 Patent”)
EX1002	File History of the ’851 Patent
EX1003	Declaration of Dr. Colin Wolden
EX1004	Engfeldt (WO 2017/123138)
EX1005	Pradhan (WO 2017/189307)
EX1006	Duarte (U.S. Patent No. 11,227,522)
EX1007	Carl M. Lampert, “Durability of Electrochromic Switching Devices for Glazings,” Lawrence Berkeley Laboratory Report No. LBL-24103 Rev., presented at The International Congress on Optical Science and Engineering, The Hague, The Netherlands, Mar. 12-15, 1990, and published in <i>Optical Materials Technology for Energy Efficiency and Solar Energy Conversion IX</i> , Proc. SPIE Vol. 1272, 1990.
EX1008	Hulya Demiryont & Kenneth Shannon III, “Solid-State Monolithic Electrochromic Switchable Visors and Spectacles,” in <i>Head- and Helmet-Mounted Displays XIV: Design and Applications</i> , Proc. of SPIE Vol. 7326, 73260K, 2009.
EX1009	R. Vergaz, J.M. Sánchez-Pena & D. Barrios, “Microcontrolled Electrooptic System for Online Light Transmission Control of Novel Electrochromic Devices,” <i>Microwave and Optical Technology Letters</i> , Vol. 48, No. 8, pp. 1572-1574, Aug. 2006.
EX1010	Gunnar A. Niklasson & Claes G. Granqvist, “Electrochromics for Smart Windows: Thin Films of Tungsten Oxide and Nickel Oxide, and Devices Based on These,” <i>Journal of Materials Chemistry</i> , Vol. 17, pp. 127-156, 2007.
EX1011	C.G. Granqvist, E. Avendaño & A. Azens, “Novel Electrochromic Materials and Devices,” <i>46th Annual Technical Conference Proceedings</i> , Society of Vacuum Coaters, p. 75 et seq., 2003, ISSN 0737-5921.
EX1012	U.S. Patent No. 5,610,756
EX1013	U.S. Patent No. 4,519,930
EX1014	WO 03/011688
EX1015	U.S. Patent No. 4,712,879

Petition for *Inter Partes* Review of U.S. Patent No. 10,539,851
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Exhibit No.	Description
EX1016	D. Papathanasopoulos, G. Leftheriotis & E. Mitronikas, “Design, Fabrication, and Testing of an Electronic Device for the Automatic Control of Electrochromic Windows,” <i>Journal of Building Engineering</i> , Vol. 12, pp. 248-258, 2017.

LISTING OF CLAIMS

Claim 1	
[1.pre]	A method of changing an optical state of an electrochromic film, wherein the electrochromic film has a plurality of optical states, comprising:
[1.1]	selecting a desired state of the plurality of optical states;
[1.2]	injecting electric charges into the electrochromic film by a driving force, wherein the driving force includes voltage driving, current driving, and/or a combination of voltage driving and current driving;
[1.3]	determining the driving force based on the desired state of the plurality of optical states;
[1.4]	monitoring an amount of the electric charges injected into the electrochromic film; and
[1.5]	stopping injecting the electric charges when the electric charges reaches a pre-set amount corresponding to the desired state.
Claim 2	
[2]	The method of claim 1, wherein the voltage driving comprises applying an external DC voltage to the electrochromic film.
Claim 3	
[3]	The method of claim 1, wherein the current driving comprises applying an external DC current to the electrochromic film.
Claim 4	
[4]	The method of claim 1, wherein the voltage driving comprises applying an external pulsed voltage to the electrochromic film.
Claim 5	
[5]	The method of claim 1, wherein the current driving comprises applying an external pulsed current to the electrochromic film.
Claim 6	
[6]	The method of claim 1, wherein injecting electric charges into the electrochromic film comprises applying a combination of an external voltage and an external current to the electrochromic film.
Claim 7	
[7]	The method of claim 1, wherein injecting electric charges into the electrochromic film comprises applying a combination of a constant power source and a pulsed power source to the electrochromic film.

Claim 8	
[8.pre]	A method of changing an optical state of an electrochromic film, wherein the electrochromic film has a plurality of optical states, comprising:
[8.1]	selecting a desired state of the plurality of optical states;
[8.2]	extracting electric charges from the electrochromic film by a driving force, wherein the driving force includes voltage driving, current driving, and/or a combination of voltage driving and current driving;
[8.3]	determining the driving force based on the desired state of the plurality of optical states;
[8.4]	monitoring an amount of the electric charges extracted from the electrochromic film; and
[8.5]	stopping extracting the electric charges when the electric charges reaches a pre-set amount corresponding to the desired state.
Claim 9	
[9]	The method of claim 8, wherein the voltage driving comprises applying an external DC voltage to the electrochromic film.
Claim 10	
[10]	The method of claim 8, wherein the current driving comprises applying an external DC current to the electrochromic film.
Claim 11	
[11]	The method of claim 8, wherein the voltage driving comprises applying an external pulsed voltage to the electrochromic film.
Claim 12	
[12]	The method of claim 8, wherein the current driving comprises applying an external pulsed current to the electrochromic film.
Claim 13	
[13]	The method of claim 8, wherein extracting electric charges from the electrochromic film comprises applying a combination of an external voltage and an external current to the electrochromic film.
Claim 14	
[14]	The method of claim 8, wherein extracting charges into the electrochromic film comprises applying a combination of a constant power source and a pulsed power source to the electrochromic film.
Claim 15	
[15.pre]	A method of changing an optical state of an electrochromic film, comprising:
[15.1]	setting a plurality of pre-determined optical states of the electrochromic film;

[15.2]	determining an amount of electric charges corresponding to each of the plurality of pre-determined optical states;
[15.3]	selecting a desired state of the plurality of pre-determined optical states; and
[15.4]	determining a driving force, wherein the driving force includes voltage driving, current driving, and/or a combination of voltage driving and current driving;
[15.5]	adjusting an amount of electric charges within the electrochromic film to the determined amount of electric charges corresponding to the selected desired state.
Claim 16	
[16]	The method of claim 15, wherein adjusting the amount of electric charges within the electrochromic film comprises applying the voltage driving, the voltage driving including an external DC voltage, an external pulsed voltage, or combination thereof to the electrochromic film.
Claim 17	
[17]	The method of claim 15, wherein adjusting the amount of electric charges within the electrochromic film comprises applying the current driving, the current driving including an external DC current, an external pulsed current, or a combination thereof to the electrochromic film.
Claim 18	
[18]	The method of claim 15, wherein adjusting the amount of electric charges within the electrochromic film comprises applying a combination of an external voltage and an external current to the electrochromic film.
Claim 19	
[19]	The method of claim 18, wherein the external voltage includes DC voltage and pulsed voltage, and the external current includes DC current and pulsed current.
Claim 20	
[20]	The method of claim 15, wherein the plurality of pre-determined optical states include a clear state and a dark state of the electrochromic film.

Ambilight, Inc (“Petitioner”) petitions for *inter partes* review (IPR) of Claims 1-20 (“Challenged Claims”) of U.S. Patent No. 10,539,851 (“the ’851 Patent,” EX1001). The evidence addressed in this Petition compellingly demonstrates that institution of *inter partes* review is warranted and that the Challenged Claims of the ’851 Patent should be cancelled as obvious over the cited prior art. (EX1003, ¶¶1-218)

I. REQUIREMENTS FOR IPR UNDER 37 C.F.R. § 42.104

A. Grounds for Standing (37 C.F.R. § 42.104(A))

Petitioner certifies that the ’851 Patent is available for IPR and that Petitioner is not barred or estopped from requesting IPR challenging Claims 1-20 on the grounds set forth below.

B. Identification of Claims Being Challenged (37 C.F.R. § 42.104(B))

Petitioner requests IPR of Claims 1-20 of the ’851 Patent and that these claims be found invalid on the following bases:

Ground	Claims	Basis of Unpatentability
1	1-2, 4, 7-9, 11, 14-16 and 20	§103 – Engfeldt (EX1004)
2	3, 6, 10, 13 and 17-18	§103 – Engfeldt in view of Pradhan (EX1005)
3	3-5, 7, 10-12, 14, 16-17	§103 – Engfeldt in view of Duarte (EX1006)
4	19	§103 – Engfeldt in view of Pradhan (EX1005) and Duarte (EX1006)

Although Engfeldt (EX1004) discloses all of the limitations of the Challenged Claims in Ground 1, Petitioner is relying on §103 for Ground 1 because of alternative

obviousness arguments for certain claim limitations, and because “a disclosure that anticipates under §102 also renders the claim invalid under §103, for anticipation is the epitome of obviousness.” *Realtime Data, LLC v. Iancu*, 912 F.3d 1368, 1373 (Fed. Cir. 2019) (internal quotations and citations omitted). Petitioner further relies on Pradhan (EX1005) and Duarte (EX1006) as alternative obviousness positions for certain dependent claims and limitations, including in the event the Board determines that Engfeldt alone does not disclose or render obvious every aspect of certain claims in Ground 1.

The ’851 Patent is subject to post-AIA law. The ’851 Patent was filed as U.S. Patent Application No. 15/913,669 on March 6, 2018, and it does not claim any earlier priority. (*See* EX1001, Cover.) Petitioner therefore treats March 6, 2018 as the Earliest Effective Filing Date of the ’851 Patent.

Each of the references relied upon by Petitioner is prior art under post-AIA 35 U.S.C. §102:

Reference	Effective Filing Date	Publication Date	AIA Prior Art Status
Engfeldt (EX1004)	1/9/2017	7/20/2017	§102(a)(1)
Pradhan (EX1005)	4/19/2017	11/2/2017	§102(a)(1)
Duarte (EX1006) ¹	10/27/2017	4/25/2019	§102(a)(2)

¹ Duarte qualifies as prior art under § 102(a)(2) because it was effectively filed on October 27, 2017, before the March 6, 2018 earliest effective filing date of the ’851

II. SUMMARY OF THE '851 PATENT

A. Specification and Claims

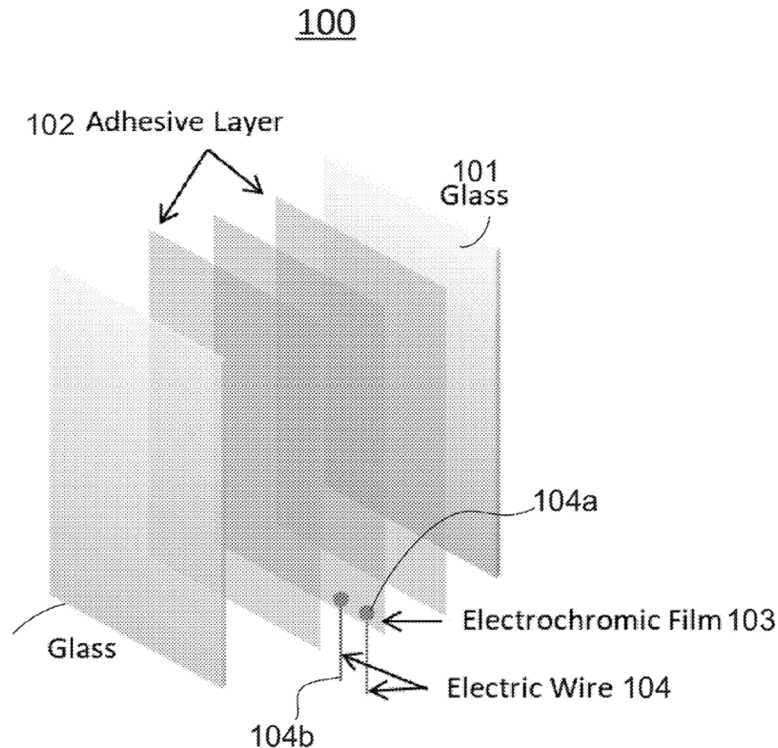
The '851 Patent relates generally to a method of changing an optical state of an electrochromic film with a plurality of optical states. (EX1001, Abstract.) The electrochromic film can be used in glass windows, smart windows or other devices that require changing optical states based on lightness, transparency, color or reflectance. (*Id.*, 1:15-28; EX1003, ¶38.)

The '851 specification explains that electrochromism is “reversibly changing optical properties by using bursts of charges to cause electrochemical redox (reduction and oxidation) reactions in electrochromic materials.” (EX1001, 1:12-15.) These “changing optical properties” “may include transmittance, reflectance, absorptance and emittance” such that electrochromic materials “exhibit a reversible color changes.” (*Id.*, 1:15-18.)

The '851 specification explains that the optical state – or tint – of an electrochromic film depends on charge. Specifically, “[t]he optical state of an electrochromic material depends on the amount of charge injected or extracted,” and “[t]he electrochromic film’s optical state could be set at any state by controlling the amount of charges.” (*Id.*, 1:18-24; EX1003, ¶39.)

Patent, and was subsequently published as a U.S. patent application on April 25, 2019.

Figure 1 depicts a simplified electrochromic device 100, such as a smart window, including outer glass layers 101, an electrochromic film 103 sandwiched between the glass layers, and adhesive layers 102 attaching the electrochromic film 103 to the glass layers 101. (*Id.*, 3:23-34.)



EX1001, Figure 1

Against this backdrop, the '851 Patent sets out to “propose different methods for changing optical states of electrochromic materials.” (*Id.*, 1:29-30.) Although the specification employs a controller-based system for such transition, it acknowledges in the background section that conventionally, “Electric controller[s] are used to control the electrochromic films integrated with glass windows (i.e., smart windows).” (*Id.*, 1:24-28.)

The '851 Patent does not focus on any particular control technique, but instead discloses a wide variety of ways to inject into or extract charge from the electrochromic film to change the optical state of the electrochromic material. (*Id.*, 7:60-64.) The '851 specification provides that “[b]oth voltage driving and current driving can be employed to inject/extract electric charges,” and that “the combination of voltage driving and current driving can also be employed.” (*Id.*, 7:64-8:2.) The '851 specification further states that “the voltage driving and the current driving can be operated at either direct current (DC) or alternating current (AC).” (*Id.*) Likewise, a “combination of voltage driving and current driving, pulsed voltage driving and current driving, combination of pulsed and DC driving, etc. can also be employed to change electrochromic materials to a desired optical state.” (*Id.*, 10:29-22.) The '851 Patent does not favor one method over another: “[a]s long as the required amount of electric charges are injected or extracted, the electrochromic film can be set at a certain optical state.” (*Id.*, 8:2-4; EX1003, ¶¶40-42.)

The '851 claims reflect that same indiscriminate approach to the method of charging the electrochromic film. The '851 Patent includes three independent claims that recite a method of changing an optical state of an electrochromic film that has a plurality of optical states. (EX1001, Claims 1, 8, 15.) Rather than being limited to any one specific method of injecting or extracting charge, they recite a series of broad charging/discharging methods, including voltage driving, current driving, DC

voltage, DC current, pulsed voltage, pulsed current, and combinations of voltage and current. (*See, e.g.*, Claims 1-20; EX1003, ¶¶43-44.)

As shown in this Petition, prior art not cited or considered during prosecution of the '851 Patent discloses the features of the independent and dependent claims of the '851 Patent including methods for charging/discharging electrochromic films based on the desired optical state of the film, using different driving forces including voltage driving and current driving (and different constant and pulsed variants of voltage driving and current driving), monitoring the charge, and then stopping the injecting/extracting of charge when the electrochromic film reaches its desired state – well before March 6, 2018.

B. Prosecution History

The application underlying the '851 Patent was not subjected to a thorough examination. Original claims 1-20 were all rejected as obvious over Lee, U.S. Patent Publication No. 2004/0150867. The Applicant responded by amending independent claims 1 and 8 such that the step of injecting into or extracting electric charges from the electrochromic film is done “by a driving force, wherein the driving force includes voltage driving, current driving, and/or a combination of voltage driving and current driving.” (EX1002 at pp. 82-83.) The Applicant also amended claims 1 and 8 to include a step of “determining the driving force based on the desired state of the plurality of optical states.” (*Id.*) Similarly, for independent claim 15, the

applicant added a step of “determining a driving force, the driving force including voltage driving, current driving, and/or a combination of voltage driving and current driving.”

Applicant conceded that “Lee discloses a thin film of electrochromic material with a controlled ratio of constituents” that is “connected to the cathode of a battery (or other emf source)” to provide “a source of voltage placed with the conductive substrate” to “drive the material to change to a colored state.” However, Applicant argued that the amended claims are patentable over Lee because “Lee fails to teach using driving forces to manage the rate of changes of injection/extraction of electric charges in electrochromic films.” (*Id.*)

Based on Applicant’s claim amendments and remarks, the Examiner withdrew all rejections and issued a Notice of Allowance. The Examiner’s reasons for allowance were unclear, as he merely stated that “the prior art fails to teach a combination of all the claimed features as presented in claims 1, 8, and 15.” (EX1002, pp. 90-97.) Applicant submitted additional prior art after the Notice of Allowance, but the Examiner quickly issued another similar Notice of Allowance with no additional rejections. (*Id.* at pp. 106-107.)

III. PERSON OF ORDINARY SKILL IN THE ART

The level of ordinary skill in the art is evidenced by the references. *See In re GPAC Inc.*, 57 F.3d 1573, 1579 (Fed.Cir.1995). A person of ordinary skill in the art

(“POSA”) as of the priority date of the ’851 Patent would have had at least a bachelor’s degree in electrical engineering, materials science, chemical engineering, physics, or a similar discipline, and at least 2-3 years of experience working with electrochromic devices, thin-film optical devices, smart-window systems, electrochemical devices, or control systems for such devices. Additional education, such as a master’s degree or Ph.D. in one of these fields, could substitute for some practical experience. (EX1003, ¶30.)

IV. CLAIM CONSTRUCTION (37 C.F.R. § 42.104(b)(3))

The claims should be construed as having their plain and ordinary meaning to a person of ordinary skill in the art according to the *Phillips* standard. *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005); 37 C.F.R. §42.100. Petitioner submits that no formal claim constructions are necessary because “claim terms need only be construed to the extent necessary to resolve the controversy.” *Wellman, Inc. v. Eastman Chem. Co.*, 642 F.3d 1355, 1361 (Fed. Cir. 2011). Petitioner reserves the right to respond to any constructions offered by Patent Owner or adopted by the Board. Petitioner is not conceding that each challenged claim satisfies all statutory requirements, nor is Petitioner waiving any arguments concerning claim scope or grounds that can only be raised in district court. (EX1003, ¶¶31-32.)

V. GROUND 1: CLAIMS 1-2, 4, 7-9, 11, 14-16 AND 20 ARE OBVIOUS IN VIEW OF ENGFELDT

A. Overview of Engfeldt

Engfeldt is directed to the same field as the '851 Patent: controlling transitions between optical states of an electrochromic device by controlling the manner of charging/discharging the electrochromic film. As background, Engfeldt explains that “[t]he transmittance is typically controlled by charging or discharging the electrochromic device,” and that, by changing the electric potential across the device, the result is “a colouring or bleaching of the electrochromic layer and/or counter electrode layer.” (*Id.*, 1:13-21.) Engfeldt sets forth an improved method of controlling electrochromic devices that comprises obtaining a target colouring level, measuring the existing colouring level, and then charging or discharging the device to achieve the desired optical state. (EX1004, Abstract; EX1003, ¶46.)

Engfeldt addresses the challenge of how to change the transmittance of an electrochromic device quickly, while minimizing overdriving or damaging the device. “When a change of transmittance is requested, ... [t]he change is typically requested to be performed as rapidly as possible, which is favoured by applying a high voltage across the electrochromic device. However, electrochromic devices may be damaged, or at least the life time of an electrochromic device may be significantly reduced [if] too high voltages are applied.” (EX1004, 1:23-29.) Engfeldt thus sets out “to find a suitable compromise between transition time and

applied voltages” while charging/discharging as rapidly as possible without damaging the device. (EX1004, 2:21-25, 1:23-29; EX1003, ¶¶46-49.)

Engfeldt discloses several embodiments to achieve its objective, each of which starts with the steps of: (1) determining the target colouring level and the initial colouring level, (2) obtaining the initial device charge and (3) measuring the initial open circuit voltage. (EX1004, Abstract, Figs. 1-4; EX1003, ¶¶50-57.) Based on these parameters, Engfeldt’s system enters the charging state 229.

The charging state of each of the embodiments includes a calibration stage 239 in which the device’s own electrical behavior is monitored to determine an appropriate main charging/discharging voltage for a transition stage:

When a change of transparency is requested, the electrochromic device is changed into a charging state. This charging state can in turn comprise a number of sub- states ... In a first substate, a calibration state, relatively gentle charging is performed while monitoring the responses on charge and open circuit voltage to different charging voltages. From this monitoring, suitable conditions for the main charging operation are deduced. (*Id.*, 7:24-31.)

FIG. 1 and its associated description illustrate how the calibration works. During the calibration substate 239 (highlighted in yellow below), “a calibration ramping is performed, ramping a voltage applied between electrodes of the electrochromic device,” and “a calibration charging current is measured.” (*Id.*, 9:24-10:28.) Engfeldt explains that “[t]he charging current corresponds to a change of the charge of the electrochromic device,” and that the voltage ramping is intermittently

interrupted so that “a calibration open circuit voltage” can be measured. (*Id.*, 10:24-34.) According to Engfeldt, “[t]he evolution of the charging current, or therefrom deducible quantities, such as the charge of the electrochromic device, and of the open circuit voltage, reveals details of the charging conditions of the electrochromic device.” (*Id.*, 11:1-3; EX1003, ¶51-52.)

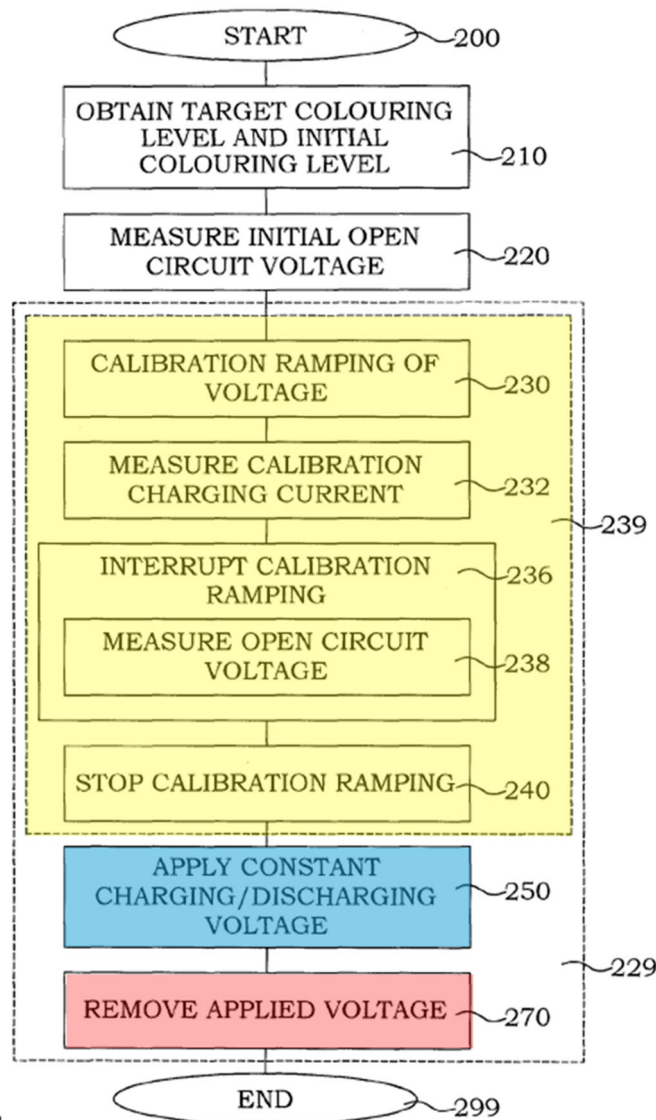


Fig. 1

EX1004, Figure 1

When a calibration condition is met, “the calibration ramping of the voltage is stopped” at step 240 and the device enters the main charging stage at step 250 (highlighted in blue), where “a constant main charging/discharging voltage is applied.” (EX1004, 11:21-25.) “The main charging/discharging voltage is thereby selected in dependence of the ramped voltage when stopped,” and “[d]ue to the information obtained during the calibration ramping, the now selected main charging/discharging voltage can now be set to compensate for variations in configuration, temperature, age, etc.” (*Id.*, 11:23-29.) In other words, the measured charging-current and open-circuit-voltage response during calibration stage determines the main charging/discharging voltage applied in the subsequent stage. (EX1003, ¶53.)

When Engfeldt’s system is charged/discharged to reach its target coloring level, application of voltage is removed at step 270 (highlighted in red). (*Id.*, 11:31-33; EX1003, ¶53-54.)

Engfeldt teaches that “there are many possible procedures to use for arriving to the intended transmittance level.” (*Id.*, 15:24-30.) Another method for controlling an electrochromic device is shown in Fig. 3, which again includes calibration 239 (yellow), applying the main charge/discharge 250 (blue), and stopping the main charge/discharge 270 (red). In this embodiment, the charging state 229 starts with calibration 239 (yellow) as in the Fig. 1 embodiment, but then proceeds to the static

state 259 that measures charging currents and open circuit voltages to reach the final desired optical condition. (*Id.*, 15:27-29; EX1003, ¶55.)

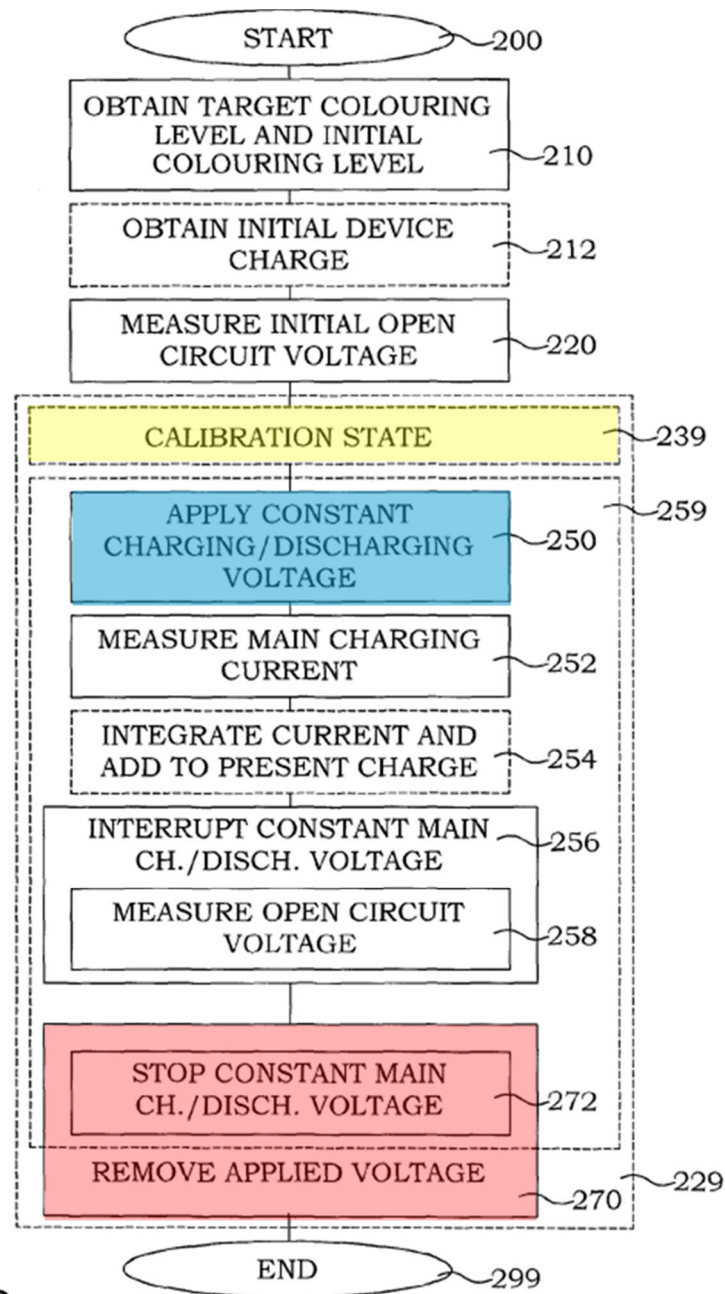


Fig. 3

EX1004, Fig. 3

After applying a constant charging/discharging voltage in step 250 (blue), the charging current is measured in Step 252. The measured charging current is integrated into a main charge change, and the present device charge is updated by the main charge change. (*Id.*, 16:9-12.) The main charging/discharging voltage can be interrupted intermittently and temporarily (256) to measure the open circuit voltage between the electrodes of the electrochromic device. (*Id.*, 15:33-16:4.) When the level of charging meets the main charging current and/or open circuit voltage desired state, the applied voltage is removed (270, red) which includes stopping the application of the charging/discharging voltage (272). (EX1004, 16:4-8, Fig. 3; EX1003, ¶55.)

Like the control method of Fig. 1, when the system is charged/discharged to reach its target coloring level, application of voltage is removed at step 270. (EX1004, Fig. 3.)

Yet another method for controlling an electrochromic device is shown in Fig. 4, which again includes calibration 239 (yellow), applying the main charge/discharge 250 (blue), and removing the main charge/discharge 270 (red). The Fig. 4 method is similar to the Fig. 3 method, except that it allows more gradual charging as the electrochromic film approaches its final transmittance state. In particular, the main charging/discharging voltage is first stopped in step 260 when a main open circuit voltage condition is met, and then a step of trickle charging 268

(green) continues until the target coloring level is reached. (*Id.*, 17:15-27.) The trickle charging/discharging is applied in small amounts to slowly approach the final transmittance. (*Id.*, 17:29-33.) Engfeldt contemplates measuring the present device charge and open circuit voltage during trickle charging. (*Id.*, 17:29-18:5.) Engfeldt teaches that this may be useful when, for instance, high voltages are required to charge/discharge the electrochromic film. (EX1003, ¶56.)

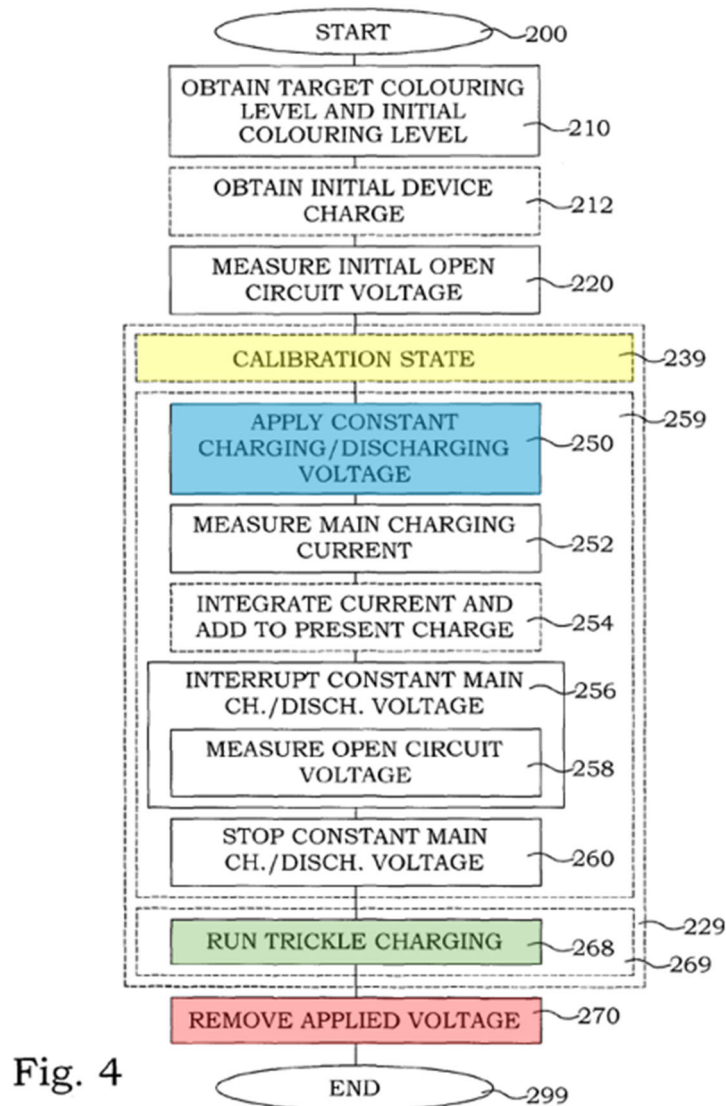


Fig. 4

EX1004, Fig. 4

Like the prior embodiments, when the system reaches the target coloring level, the applied voltage is removed at step 270 (red). (*Id.*, 17:25-27; (EX1003, ¶56.)

Engfeldt contemplates broad uses of its method of controlling in many different applications, including “vehicle mirrors, construction windows, spectacles or different kinds of imaging devices.” (EX1004, 1:10-14; EX1003, ¶58.)

B. Claims 1-2, 4, 7-9, 11, 14-16 and 20 are Invalid Under §103 in View of Engfeldt

1. Claim 1

a) [1.pre]²

To the extent the preamble is limiting, Engfeldt discloses “a method for controlling an electrochromic device which presents a transmittance that is dependent on a charge of the electrochromic device.” (EX1004, 3:26-30; EX1003, ¶¶59-63.) Engfeldt likewise explains that its technology is “applicable on most prior art electrochromic films, where the electrochromic film presents a transmittance that is dependent on a charge of the electrochromic film,” and that “the electrochromic film comprises two electrodes used for controlling the charging and discharging of the electrochromic film.” (EX1004, 6:29-32.) Referring to Figures 5-6, Engfeldt provides that the “electrochromic film 10 is coloured/bleached by applying an

² The full language of each claim element can be found in the Listing of Claims, page vii.

external voltage pulse between the electron conducting layers 24, 34.” (*Id.*, 24:30-25:3.)

Engfeldt’s electrochromic film likewise has a plurality of optical states. Engfeldt teaches obtaining “a target colouring level” and an “initial colouring level,” where the target “is a representation of the requested colouring level” and “is represented by a percentage value, where 100% corresponds to a fully charged condition and 0% corresponds to a fully discharged condition, which in turn typically corresponds to a maximum colouring and a fully bleaching, respectively, of the electrochromic device.” (*Id.*, 8:15-9:8.) Maximum/minimum coloring/bleaching are not the only states, as “the target colouring level could be expressed in any kind of scale,” and “transmittance values may also be associated to colour percentage, e.g. by a mathematical function or a table.” (*Id.*, 9:10-15.)

A POSA would therefore have understood Engfeldt to disclose a method of changing an optical state of an electrochromic film, wherein the electrochromic film has a plurality of optical states. (EX1003, ¶¶59-63.)

b) [1.1]

Engfeldt discloses selecting a desired state of the plurality of optical states by obtaining a “target colouring level.” (EX1003, ¶¶64-68.) Specifically, Engfeldt explains that, in step 210, “a target colouring level and a measure of an initial colouring level are obtained,” and that “[t]he target colouring level is a

representation of the requested colouring level.” (EX1004, 8:15-21.) “[T]he target colouring level is represented by a percentage value, where 100% corresponds to a fully charged condition and 0% corresponds to a fully discharged condition, which in turn typically corresponds to a maximum colouring and a fully bleaching, respectively, of the electrochromic device.” (*Id.*, 8:27-9:8.) Thus, a POSA would have understood Engfeldt to disclose selecting a desired state from among a plurality of optical states by selecting the target colouring level/transmittance to which the electrochromic device is to be driven. (EX1003, ¶¶64-68.)

c) [1.2]

Engfeldt teaches injecting electric charges into the electrochromic film by a driving force that comprises voltage driving. (EX1003, ¶¶69-75.) Once the calibration condition is satisfied, “the calibration ramping of the voltage is stopped” and “a constant main charging/discharging voltage is applied.” (EX1004, 11:16-25, 15:24-16:7, 17:18-19, claim 1; Figs. 1-4.) As shown in Figures 1-4, and illustrated in annotated Figure 3 below, step 250 (blue) includes applying a “constant charging/discharging voltage.” (EX1003, ¶70.)

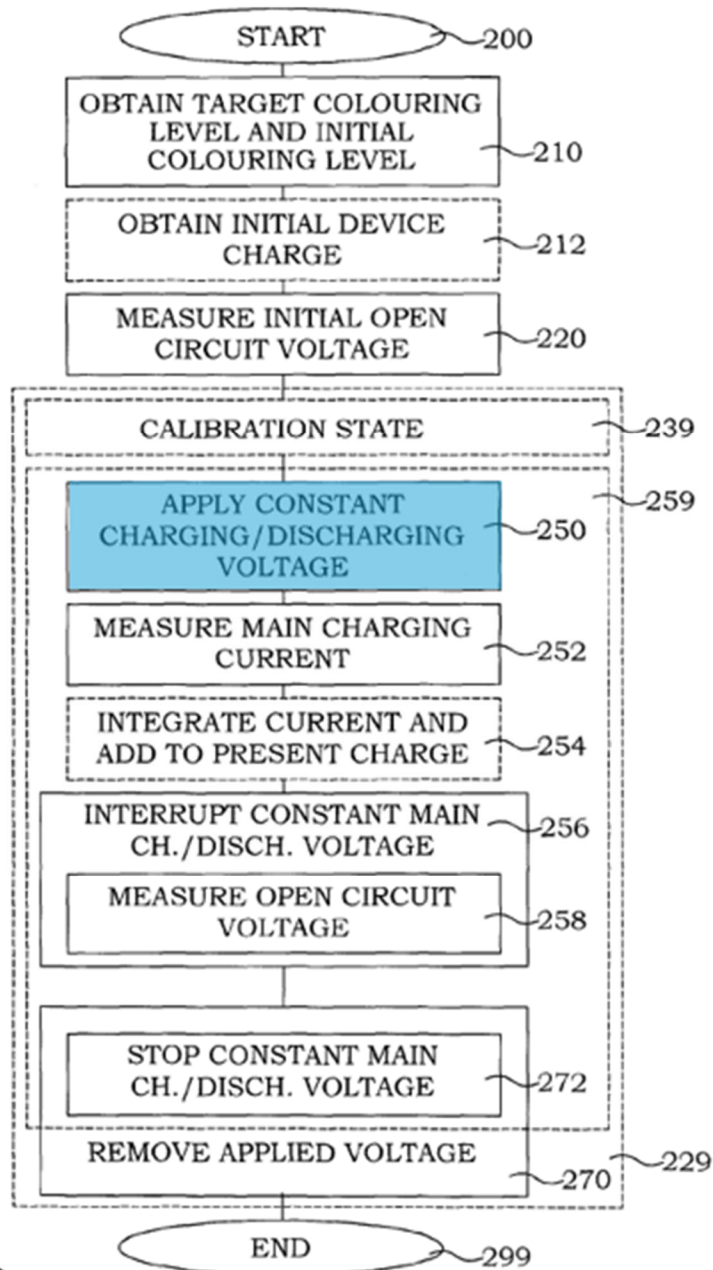


Fig. 3

EX1004, Figure 3

Additionally, Engfeldt explains that “[t]he main charging/discharging voltage is thereby selected in dependence of the ramped voltage when stopped,” and that “[d]ue to the information obtained during the calibration ramping, the now selected

main charging/discharging voltage can now be set to compensate for variations in configuration, temperature, age, etc.” (*Id.*, 11:23-29.) Engfeldt summarizes that “[t]he initial ramping is performed, and the ‘easiness’ of charging is thereby tested or calibrated. From this calibration, a suitable static voltage is selected” (*Id.*, 15:19-22.) In the Fig. 4 embodiment, the trickle charging stage (step 268) continues charging and discharging driven by an applied inter-electrode voltage, as evidenced by the subsequent removal of that voltage in step 270 “when such a target colouring level is reached”. (*Id.*, 17:23-27.)

Engfeldt also teaches injecting electric charges into the electrochromic film during the calibration stage. (EX1003, ¶72.) Engfeldt explains that, when a change of transparency is requested, the device enters a charging state and, “[i]n a first substate, a calibration state, relatively gentle charging is performed while monitoring the responses on charge and open circuit voltage to different charging voltages.” (EX1004, 7:28-30.) In the FIGS. 2-4 embodiments, during this calibration substate, “a calibration ramping is performed, ramping a voltage applied between electrodes of the electrochromic device,” and “a calibration charging current is measured.” (*Id.*, 9:24-10:28.) Engfeldt further explains that the measured calibration charging current is added to the initial device charge, which gives the present device charge. (*Id.*, 11:32, 12:1.) A POSA would thus have understood Engfeldt to also disclose

injecting charges into the electrochromic film during calibration by a voltage driving force. (EX1003, ¶¶72-74.)

A POSA would thus have understood Engfeldt to teach injecting electric charges into the electrochromic film by voltage driving during the main charging stage, trickle charging, and the calibration stage. (EX1003, ¶¶69-75.)

d) [1.3]

Engfeldt discloses determining the driving force based on the desired optical state. (EX1003, ¶¶76-80.) As discussed above, Engfeldt first obtains “a target colouring level” in Step 210 of Figs. 1-4 which “is a representation of the requested colouring level.” (EX1004, 8:15-21.) Engfeldt may then obtain and/or measure an initial device charge (Figs. 1-4), all to assess the electrochromic film’s current charge in order to determine how much charge is needed to reach the target coloring level of the desired optical state. (*Id.*, 8:20-9:8, 12:21-39; EX1003, ¶¶77.)

More particularly, Engfeldt explains that after (1) obtaining the initial coloring level and a target color level, (2) obtaining the current charge of the device, (3) figuring out how much voltage is required to hit the target level, and (4) measuring the existing voltage across the open circuit, the calibration stage helps determine whether voltage is applied at the existing level or another predetermined level. (*Id.*, 10:1-22, 7:28-31, 11:21-29, 15:19-22) Engfeldt teaches that in the calibration state, “relatively gentle charging is performed while monitoring the responses on charge

and open circuit voltage to different charging voltages,” and that “[f]rom this monitoring, suitable conditions for the main charging operation are deduced.” (EX1004, 7:28-31.) As shown in FIGS. 1 and 2, once the calibration condition is met, “the calibration ramping of the voltage is stopped” at step 240 and “a constant main charging/discharging voltage is applied” at step 250 with “[t]he main charging/discharging voltage . . . selected in dependence of the ramped voltage when stopped.” (*Id.*, 11:21-25, Figs. 1-4.) The steps in calibration stage 239 of FIGS. 1 and 2 are incorporated into the calibration stage 239 in the embodiments of FIGS. 3 and 4. “Due to the information obtained during the calibration ramping, the now selected main charging/discharging voltage can now be set.” (*Id.*, 11:26-29, *see also* 15:19-22.) (EX1003, ¶78.)

Engfeldt also explains that “the calibration ramping is selected to be started from the initial open circuit voltage or from a predetermined voltage in dependence of a relation between the target colouring level and the initial colouring level.” (*Id.*, 10:9-12.) “In other words, the starting value is adapted to the particular situation. If a small change in transmittance is requested, the initial open circuit voltage operates well as a start value. If a large change in transmittance is requested, standard starting values may instead be a better choice.” (*Id.*, 10:12-16.) A POSA would thus have understood Engfeldt to disclose determining the driving force based on the desired

optical state of the electrochromic film and the requested transmittance change.
(EX1003, ¶79.)

e) [1.4]

Engfeldt teaches monitoring the amount of electric charges injected into the electrochromic film. (EX1003, ¶¶81-87.) Engfeldt teaches that when the electrochromic device enters the main or static charging stage, a constant main charging/discharging voltage is applied: “[w]hen the calibration substate has been ended, there is a preferred static voltage, with which the main charging is intended to be performed.” (*Id.*, 15:24-29.) As shown in FIGS. 3 and 4, Engfeldt teaches that the static state utilizes “measures of charging currents and open circuit voltages in order to reach a requested final condition.” (*Id.*, 15:24-29.) Engfeldt teaches that “a main charging current is measured,” and the measured current may be used to update the “present device charge.” (*Id.*, 16:2-12.) “The application of the constant main charging/discharging voltage is interrupted, intermittently and temporarily” to measure the main open circuit voltage in the electrochromic device. (*Id.*, 15:34-16:4.) Engfeldt stops the main charging/discharging voltage when a main stop condition based on the main charging current and/or the main open circuit voltage is met. (*Id.*, 16:4-7.) A POSA would therefore have understood Engfeldt to teach monitoring an amount of electric charges injected into the electrochromic film during the main charging stage. (EX1003, ¶¶82-83.)

Engfeldt also teaches monitoring the amount of electric charges injected into the electrochromic film during calibration by measuring charging current and determining device charge from that current. During calibration, Engfeldt teaches that “a calibration charging current is measured,” that the “current charges the electrochromic device,” and that “[t]he charging current corresponds to a change of the charge of the electrochromic device.” (EX1004, 10:24-28.) Engfeldt further explains that “the evolution of the charging current, or therefrom deducible quantities, such as the charge of the electrochromic device,” is used during calibration. (*Id.*, 11:1-6.) The charging current is integrated into the calibration current charge change, and the calibration charge is added to the initial device charge to update the present device charge. (*Id.*, 12:32-13:2, 16:9-12.) A POSA would therefore have understood Engfeldt to also teach monitoring an amount of electric charges injected into the electrochromic film during calibration. (EX1003, ¶84.)

Additionally, during trickle charging, Engfeldt teaches that “measurements of the charge, leading to a present device charge ... may continue.” (*Id.*, 17:29-18:1.) A POSA would understand this to correspond to monitoring the device’s accumulated charge (i.e., the charge injected into the electrochromic film) during the trickle charging stage. (EX1003, ¶85.)

Accordingly, Engfeldt teaches monitoring injected charge during main charging, calibration and trickle charging stages. (EX1003, ¶86.)

f) [1.5]

Engfeldt teaches stopping injecting the electric charges when the charge reaches a pre-set amount corresponding to the desired optical state. (EX1003, ¶¶88-93.) Engfeldt explains that the device's transmittance depends on charge, and that "the charging current corresponds to a change of the charge of the electrochromic device." (EX1004, 3:28-30, 10:26-28, 11:31-33.) As illustrated in step 270 in FIGS. 1-4, after the main charging, "when the target colouring level is reached, any *application of a voltage* between the electrodes of the electrochromic device *is removed*." (*Id.*, emphasis added.) A POSA would therefore have understood Engfeldt to teach stopping injection of electric charges when the device reaches the charge amount corresponding to the requested target colouring level, *i.e.*, a pre-set amount corresponding to the desired state. (EX1003, ¶¶89-90.)

Engfeldt reinforces this in the methods illustrated in FIGS. 3 and 4. After calibration, main charging is performed in a static state "to reach a requested final condition," and that "a main charging current is measured." (EX1004, 15:24-30.) As shown below in Fig. 3, at "step 272, the application of the constant main charging/discharging voltage is stopped when a main stop condition based on the main charging current and/or the main open circuit voltage is met." (*Id.*, 16:4-8.) This removes the applied voltage per Step 270. As also shown below in Fig. 4, Engfeldt also discloses stopping the constant main charging/discharging voltage

(Step 260), running trickle charging (Step 268), and then removing the applied voltage (Step 270). A POSA would therefore understand Engfeldt to teach stopping charge injection based on monitored electrical quantities associated with the injected charge, when the device reaches a pre-set amount corresponding to the desired state. (EX1003, ¶¶91-92.)

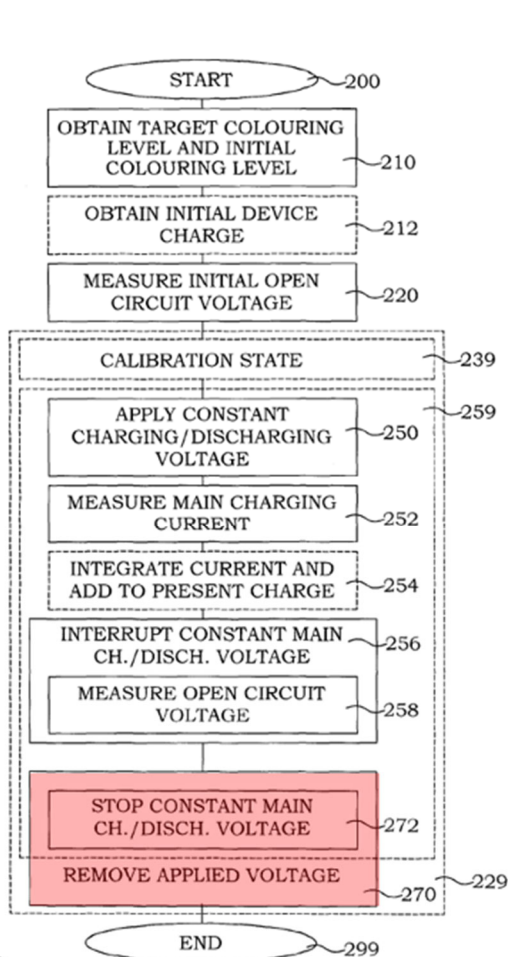


Fig. 3

EX1004, Figure 3

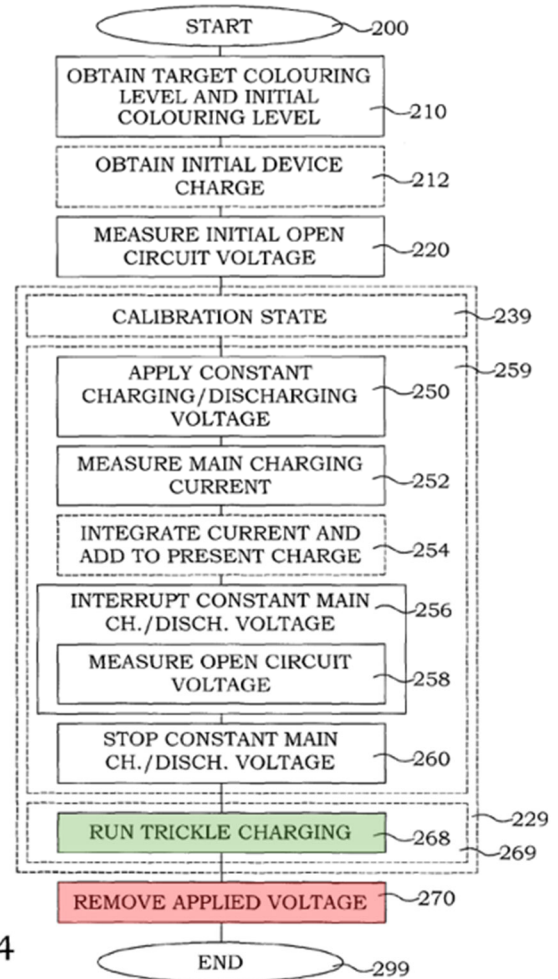


Fig. 4

EX1004, Figure 3

2. Claim 2

Engfeldt teaches the driving force includes voltage driving, *e.g.*, during main charging/discharging, trickle charging, and the calibration stage. *See* [1.2] above. (EX1003, ¶¶94-95.)

Engfeldt expressly teaches that voltage driving comprises applying an external voltage to the electrochromic film. Engfeldt explains that the electrochromic device is controlled by applying voltage between its electrodes, including “a constant main charging/discharging voltage” applied between the electrodes of the electrochromic device. (EX1004, 3:33-4:14, 9:24-33.) Engfeldt provides that “[s]uch an electrochromic film . . . is coloured/bleached by applying an *external voltage* pulse between the electron conducting layers . . . by electrodes . . . on the two sides of the stack,” thereby charging the electrochromic film. (*Id.*, 24:30-25:1, emphasis added.) A POSA would therefore have understood Engfeldt to teach applying an external voltage to the electrochromic film through electrodes on opposite sides of the electrochromic film. (EX1003, ¶96.)

Engfeldt’s applied voltage is DC. (EX1003, ¶97.) Engfeldt describes applying a constant voltage between the electrodes to drive charging or discharging in a selected direction. It explains that, during calibration, for charging “the voltages are successively increased,” while for discharging “the voltages are successively decreased,” and further notes that charging/discharging occurs “in a positive or

negative direction.” (EX1004, 9:24-33.) As illustrated in Figs. 1-4, Engfeldt then teaches that, after calibration, a “constant main charging/discharging voltage” is applied between the electrodes. (EX1004, 4:9-10, 11:21-23.) A POSA would have understood this disclosure of a constant charging/discharging voltage to describe a non-alternating voltage of selected polarity applied across the electrochromic film (*i.e.*, DC voltage) rather than an AC waveform that periodically reverses polarity. (EX1003, ¶98.)

3. Claim 4

Engfeldt teaches voltage driving, *e.g.*, during main charging/discharging. *See* [1.2] above. Engfeldt also explains that the applied voltage is applied to the electrochromic film (*see* [1.2] above), and is external (*see* claim 2 above). (EX1003, ¶¶99-100.)

Engfeldt also includes several disclosures describing that the applied external voltage can be pulsed. First starting generally, Engfeldt specifies that the “electrochromic film 10 is coloured/bleached by applying an ***external voltage pulse*** between the electron conducting layers 24, 34 by electrodes 20, 30 on the two sides of the stack.” (EX1004, 24:30-25:1, emphasis added; EX1003, ¶101.)

Second, Engfeldt specifies that in the embodiments shown in Figs. 3 and 4, the step of applying constant charging/discharging voltage 250 is interrupted 256 to measure the open circuit voltage. (EX1004, Figs. 3 and 4.) Engfeldt explains, “[i]n

step 256, the application of the constant main voltage charging/discharging is interrupted, intermittently and temporarily” in order to measure “the main open circuit voltage between the electrodes of the electrochromic device.” (*Id.*, 15:33-16:4.) And for calibration, Engfeldt teaches that the charging may be “interrupted “e.g., once every second, for a very short time” as the open circuit voltage is measured. (*Id.*, 13:7-14.) Thus, Engfeldt discloses a pattern of charging/discharging with voltage, with interruptions in the charging/discharging for short times to measure the open circuit voltage. These constant interruptions are akin to voltage pulses. (EX1003, ¶102.)

Third, Engfeldt also teaches a voltage-driven trickle charge 268 in the embodiment shown and described in Fig. 4, where the trickle charge is applied after stopping the constant main charging/discharging voltage. (*Id.*, 17:21-27.) In the trickle state, the charge of the electrochromic device is increased or decreased in small amounts to slowly approach the final transmittance. (*Id.*, 17:30-32.) Like for the constant main charging/discharging step, Engfeldt teaches taking measurements of the charge and open circuit voltage during the trickle step. (*Id.*, 17:29-18:3; EX1003, ¶103.) A POSA would understand that taking measurements of the charge and open circuit voltage would necessarily require interrupting (“e.g., once every second”) the trickle voltage applied to the electrochromic film, similar to how the main charge/discharge is measured as explained above. (EX1003, ¶103.)

In view of all the reasons above, it would have been obvious to a POSA based on Engfeldt's disclosure to use a driving voltage that comprises an external pulsed voltage. (EX1003, ¶104.) Engfeldt's charging/discharging voltage (main or trickle charge) is "intermittently and temporarily" interrupted and thus yields voltage delivered in pulses. (*Id.*)

To the extent that intermittent interruptions to Engfeldt's constant main charging/discharging voltage is not considered a "pulsed voltage," Engfeldt's applied voltage nonetheless takes a similar form as a pulsed voltage, results in the same delivery of voltage in pulses, and achieves the same control over the amount and timing of the voltage applied to the electrochromic film to charge/discharge the film. (*Id.*, ¶105.) Indeed, Engfeldt explains that "there are many possible procedures to use for arriving to the intended transmittance level," and it would have been obvious to a POSA to apply a pulsed voltage to deliver/remove charge. (*Id.*, ¶¶105-106; EX1004, 15:24-30.)

4. Claim 7

Engfeldt generally teaches injecting charge into the electrochromic film using constant power. (EX1003, ¶¶107-112.) For example, as shown in Engfeldt's Figure 3 below, "a constant main charging/discharging voltage is applied" "through the electrodes of the electrochromic device" at step 250 (blue). (EX1004, 15:24-33; 11:21-23; Abstract; Claim 1; (EX1003, ¶108.)

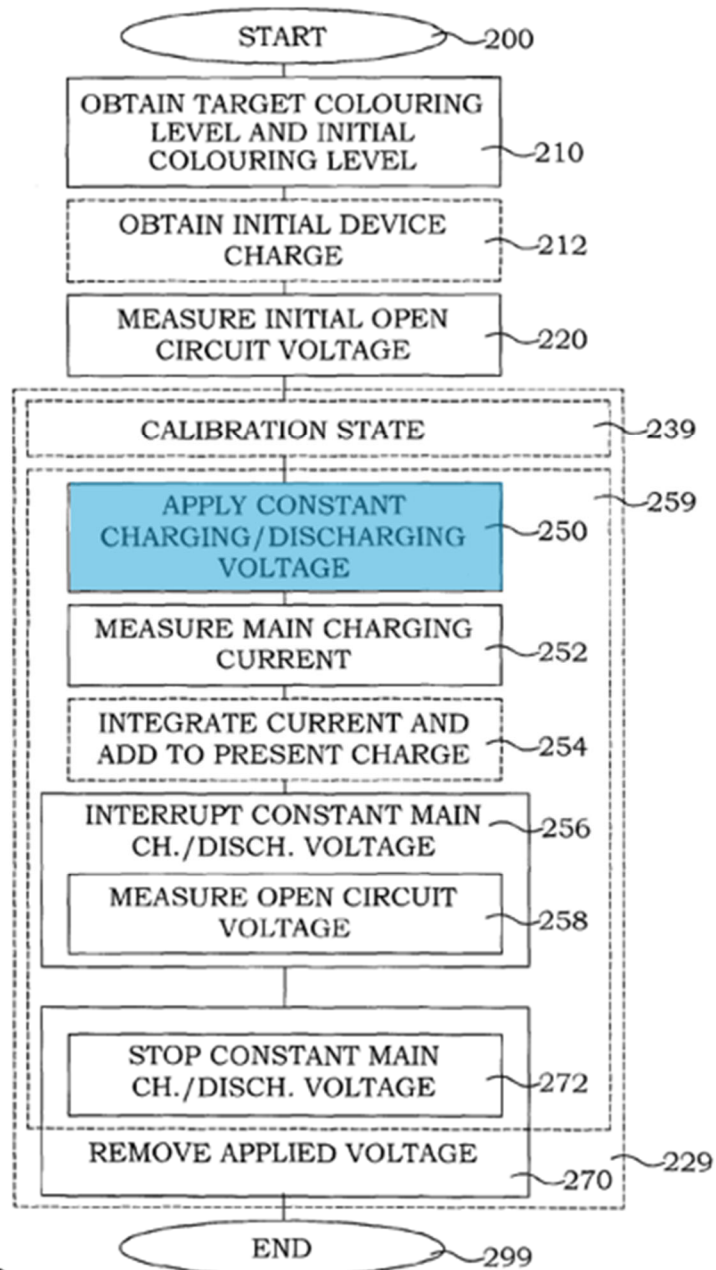


Fig. 3

EX1004, Fig. 3

A POSA would have understood this disclosure to require applying a constant power source to the electrochromic film. (EX1003, ¶109.)

As described above relative to Claim 4, Engfeldt also teaches “interrupting, intermittently and temporarily, said applying of said constant main charging/discharging voltage” in order to measure main open-circuit voltage. (*Id.*, 15:33-16:4.) This interruption may occur “e.g., once every second, for a short time” during both the main charging and any trickle charging. (*Id.*, 13:12-14.) A POSA would have therefore understood Engfeldt to teach applying a combination of a constant power source and a pulsed power source to the electrochromic film during one or both of main charging and trickle charging. (EX1003, ¶¶110-111.)

5. Claim 8

a) [8.pre]

See [1.pre]. EX1003, ¶113.

b) [8.1]

See [1.1]. EX1003, ¶114.

c) [8.2]

See [1.2]. [8.2] differs from [1.2] in that it requires “*extracting* electric charges from” (rather than “*injecting* electric charges into”) the electrochromic film. Engfeldt expressly states that its control methodology applies to both “charging and discharging,” and further explains that “charging” should be understood as “charging/discharging” in a positive or negative direction. (EX1004, 8:8-13.) Further, “[f]or a charging action, the voltages are successively increased, causing an increasing charge of the electrochromic device. For a discharging, the voltages are

successively decreased, causing a decreasing charge of the electrochromic device.” (EX1004, 9:29-33.) A POSA would have understood that Engfeldt’s voltage driving teachings apply not only to driving charge into the electrochromic film, but also discharging the film. (EX1003, ¶115.) A POSA would understand that discharging the electrochromic film means extracting electric charges from the electrochromic film. (*Id.*)

d) [8.3]

See [1.3]. (EX1003, ¶116.)

e) [8.4]

See [1.4]. *See also* [8.2] regarding Engfeldt’s teachings applying to both extracting and injecting charge. (EX1003, ¶117.)

f) [8.5]

See [1.5]. *See also* [8.2] regarding Engfeldt’s teachings applying to both extracting and injecting charge. (EX1003, ¶118.)

6. Claim 9

See claim 2 above. (EX1003, ¶119.)

7. Claim 11

See claim 4 above. (EX1003, ¶120.)

8. Claim 14

See claim 7 above. *See also* [8.2] regarding Engfeldt’s teachings applying to both extracting and injecting charge. (EX1003, ¶121.)

9. Claim 15

a) [15.pre]

See [1.pre]. (EX1003, ¶122.)

b) [15.1]

See [1.pre] and [1.1]. (EX1003, ¶123.) Engfeldt states that the target coloring level (which can be represented as a percentage value anywhere between 0% and 100%) can be “obtained,” “requested,” or “entered,” which a POSA would understand to mean “setting” the target coloring level. (EX1004, 8:19-9:8; EX1003, ¶123.)

c) [15.2]

See [1.3]. Furthermore, Engfeldt teaches determining an amount of electric charges corresponding to each of the pre-determined optical states of the electrochromic film. Specifically, Engfeldt explains that the electrochromic device, and its electrochromic film, present a transmittance that depends on charge. (EX1004, 3:26-30, 4:17-19.) Thus, Engfeldt teaches that optical state, expressed as transmittance, corresponds to charge state. (EX1003, ¶124.)

Engfeldt further teaches determining specific charge amounts for particular pre-determined optical states. For example, Engfeldt explains that the device is brought into “well-defined conditions, typically fully discharged,” after which “a measure[] of a total charge of the electrochromic film is then set to a predefined value, typically zero.” (EX1004, 7:18-8:6.) A POSA would have understood this to

be a determination or assignment of the amount of charge corresponding to the fully discharged, clear optical state. (EX1003, ¶125.) Engfeldt also teaches that, “[w]hen the minimum transmission is reached,” “a quantity q_{100} is set to the measured device charge.” (EX1004, 20:21-26.) A POSA would have understood this to be a determination of the amount of charge corresponding to the fully charged, dark optical state, *i.e.*, the minimum-transmission state. (EX1003, ¶125-126.)

Accordingly, Engfeldt teaches determining charge amounts corresponding to pre-determined optical states of the electrochromic film. And because Engfeldt teaches that transmittance depends on charge, while identifying charge values for opposite ends of the optical range, a POSA would have understood Engfeldt to teach the claimed correspondence between the plurality of pre-determined optical states and their respective amounts of electric charge. (EX1003, ¶127; *see also* [1.pre].)

d) [15.3]

See [1.1]. (EX1003, ¶128.)

e) [15.4]

Regarding “determining a driving force,” *see* [1.3]. Regarding the driving force including “voltage driving, current driving, and/or a combination of voltage driving and current driving,” *see* [1.2]. (EX1003, ¶129.)

f) [15.5]

Engfeldt teaches adjusting the amount of electric charge within the electrochromic film to the amount corresponding to the selected desired state. As

discussed in [15.2], Engfeldt explains that the film's transmittance depends on its charge, such that reaching the selected target coloring level corresponds to reaching the associated charge condition. (EX1004, 3:26-30, 4:17-19.) Engfeldt further teaches applying a "constant main charging/discharging voltage" between the electrodes, where that voltage is selected based on the preceding calibration. (EX1004, 4:9-13; 11:21-25.) Engfeldt also teaches monitoring and updating the device charge during that operation: the charging current is measured and integrated into a charge change, and the "present device charge is updated" accordingly. (*Id.*, 13:7-12; 16:9-17.) A POSA would have thus understood Engfeldt to disclose adjusting the amount of charge in the electrochromic film toward the amount associated with the selected optical state. (EX1003, ¶¶130-131.)

Engfeldt's Figure 4 embodiment with trickle charging makes that adjustment even more explicit. Engfeldt explains that, as the device comes closer to the intended final transmittance, the static-state operation may be "a somewhat coarse charging method," so the constant main charging/discharging voltage is stopped at step 260 and followed by a trickle substate. (EX1004, 17:15-27.) In step 268, "a trickle charging is run" until "the target colouring level is reached." (*Id.*) Engfeldt further explains that, in this trickle state, "the charge of the electrochromic device is increased, if a charging is requested, or decreased, if a discharging is requested, in small amounts, to slowly approach the final transmittance," and that charge

measurements may continue during this substate. (*Id.*, 17:29-18:1.) A POSA would understand this embodiment to teach adjusting the charge to the determined amount corresponding to the selected desired state, including a final fine adjustment as the film approaches the desired target coloring level and optical state. (EX1003, ¶131.)

10. Claim 16

See claims 2 and 4 above. (EX1003, ¶132.)

11. Claim 20

Engfeldt teaches that the plurality of pre-determined optical states include a clear state and a dark state of the electrochromic film. Engfeldt states that the target coloring level may be represented as a percentage value, where “100% corresponds to a fully charged condition and 0% corresponds to a fully discharged condition, which in turn typically corresponds to a maximum colouring and a fully bleaching, respectively, of the electrochromic device.” (EX1004, 8:32-9:9.) A POSA would have understood Engfeldt’s “maximum colouring” state to correspond to a dark state, and Engfeldt’s “fully bleaching” state to correspond to a clear state. (EX1003, ¶133.)

VI. GROUND 2: CLAIMS 3, 6, 10, 13, AND 17-18 ARE OBVIOUS OVER ENGELDT IN VIEW OF PRADHAN

A. Overview of Pradhan

Pradhan is directed to methods for controlling an optical transition and the ending state of an optically switchable device. (EX1005, Abstract.) Pradhan teaches

controller-based techniques for electrically driving an electrochromic device from one optical state to another and for using measured electrical feedback to control that transition. More specifically, Pradhan discloses “improved methods for driving optical transitions in electrochromic devices,” using controlled electrical conditions, where the device’s electrical response during the transition is used as feedback to assess progress and control the device’s movement toward a desired optical state. (*Id.*, [0004]-[0006]; EX1003, ¶134.)

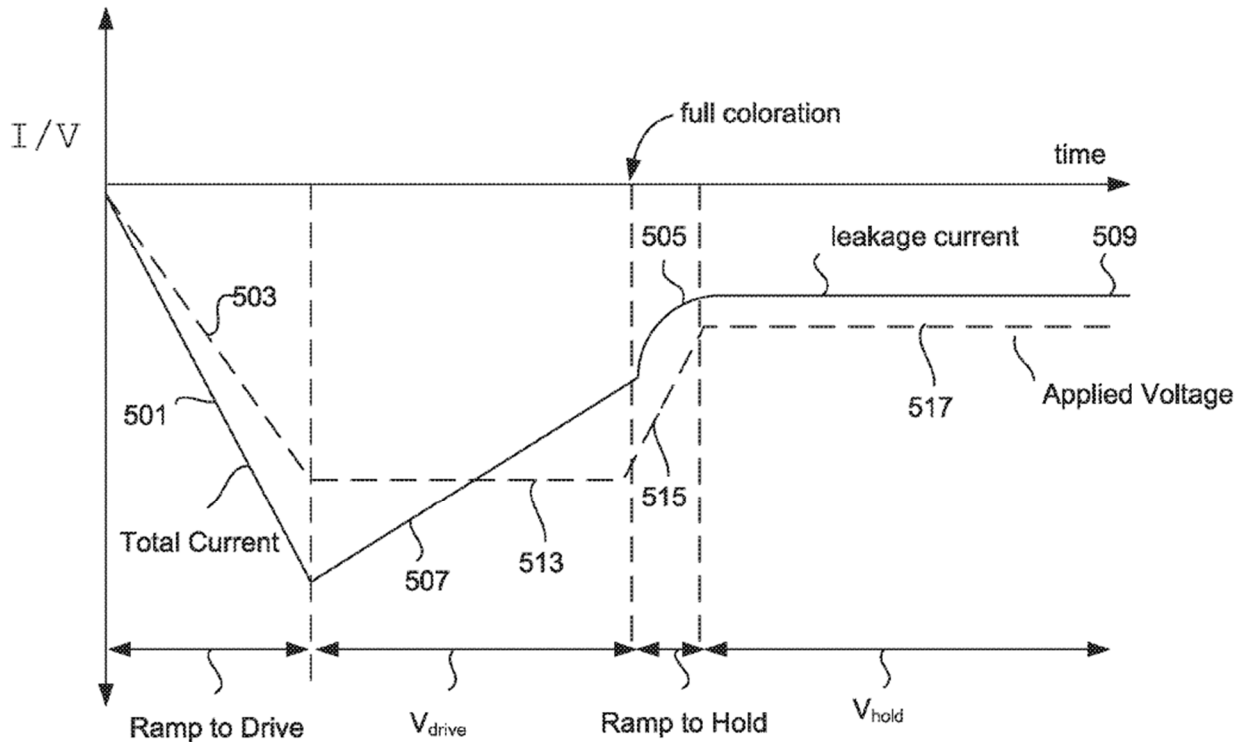
Pradhan explains that its embodiments “relate to methods for transitioning an optically switchable device using feedback obtained during the transition to control the ongoing transition,” and that the device “can be probed by applying certain electrical conditions (e.g., voltage pulses and/or current pulses)” such that “[a]n electrical response to the probing can be used as feedback to control the ongoing transition.” (EX1005, [0005].) Pradhan teaches driving the optical transition with voltage or current, and more specifically “a method of controlling an optical transition of an optically switchable device from a starting optical state to an ending optical state,” including “applying a voltage or current for driving the optically switchable device,” “determining an electrical characteristic of the optically switchable device,” and “using the determined electrical characteristic as feedback.” (*Id.*, [0006], EX1003, ¶135.)

Pradhan contemplates that the voltages supplied by the external power source may be DC voltages or AC voltages. (*Id.*, [0259].) The supplied voltage signals may be converted to pulse-width modulated voltage signals. (*Id.*) Pradhan also teaches that the modulated oscillating drive voltage has an appropriate wave profile to account for frequency, duty cycle, mean voltage, amplitude and other factors. (*Id.*, [0260].) This level of control permits Pradhan's system to transition to any optical state over the full range of optical states between the two end states. (*Id.*; EX1003, ¶136.)

Pradhan likewise contemplates using both voltage and current to drive the optical transition from a first optical state to a second optical state. (*Id.*, [0172].) Pradhan teaches a control algorithm that uses drive voltage to meet the speed of the desired transition, but then switching to an applied current to drive the charging/discharging transition to a desired optical state. (*Id.*) The current is sufficiently great to increase the speed of the transition, but not so great that it degrades or damages the electrochromic device. (*Id.*; EX1003, ¶137.)

Pradhan also describes specific driving techniques for carrying out such optical transitions. One technique is illustrated in Figure 5 below in which the applied voltage profile is shown by the dashed line, and the current density is shown by the solid line. (EX1005, [0108]-[0109].) The drive voltage is applied during at least a portion of the optical transition to speed the transition, and then a "hold

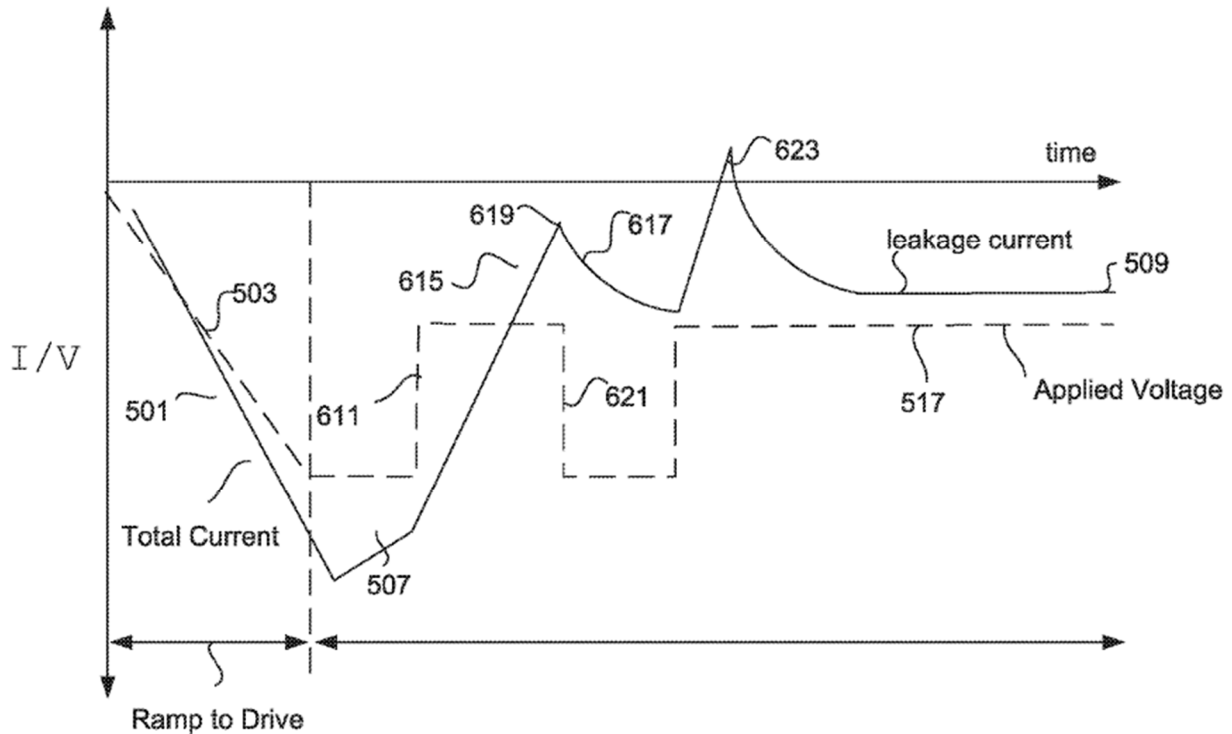
voltage” is applied to maintain the device in the ending optical state. (EX1005, [0052]-[0053], [0125].) Thus, Pradhan confirms that electrochromic transitions may be controlled by varying the externally applied drive conditions over the course of the transition. (EX1003, ¶138.)



EX1005, Figure 5

In another technique shown in Figure 6B below, Pradhan shows an initial ramping of voltage to the main drive voltage V_{drive} to increase current flow to transition from one optical state to another. (*Id.*, [0124].) Because the optical transition is not complete, the system alternates or pulses the voltage between the main drive voltage V_{drive} and the hold voltage V_{hold} as illustrated by pulse transitions 611 and 621. (*Id.*) When the current level 623 indicates that the optical transition is

complete, Pradhan teaches that the volage remains at the constant hold voltage V_{hold} level for the duration of the ending of the optical state. (*Id.*) As is the case with other variants disclosed in Pradhan, the optical state may be a maximum, minimum or intermediate optical state. (*Id.*; EX1003, ¶139.)



EX1005, Figure 6B

Pradhan also discloses using both constant voltage and pulsed voltage to reach a desired intermediate optical state. (*Id.*, [0261].) Pradhan first applies a constant voltage pulse of selected magnitude and duration to speed the transition, and then backs off to a “higher frequency voltage oscillation” to achieve the intermediate optical state. (*Id.*; EX1003, ¶140.)

Pradhan emphasizes that electrical feedback may be used to determine whether the transition has progressed sufficiently and to adjust the applied electrical conditions in real time. Specifically, Pradhan states that “feedback is used to determine when an optical transition is complete or nearly complete,” and that “electrical probing and monitoring” may be used “to determine when an optical transition . . . has proceeded to a sufficient extent that the application of a drive voltage can be terminated.” (EX1005, [0093]-[0094].) One example probing technique “involves pulsing the applied drive voltage by dropping it to the level of the hold voltage . . . and monitoring the current response,” where “the device control system determines that it is now time to transition from the drive voltage to the hold voltage” when the measured response reaches a threshold. (*Id.*, [0122].) Pradhan also teaches using open-circuit-voltage-based feedback and, in some embodiments, determining “the total delivered charge density” by integrating current over time to assess whether the optical transition is nearly complete. (*Id.*, [0150], [0157], [0159]; EX1003, ¶141.)

Pradhan therefore presents a controller-based framework in which either voltage or current (or both) drives an electrochromic transition, while measured electrical characteristics are used to monitor progress, refine control, and determine when the desired ending optical state has been reached. (*Id.*, [0005]-[0006], [0093]-[0094], [0109], [0122], [0157].) Pradhan’s control methods may be used in various

optically switchable devices, including electrochromic windows. (*Id.*, [0007]; EX1003, ¶142.)

B. Motivation to Combine Engfeldt With Pradhan

A POSA would have been motivated to combine the methods of charging/discharging electrochromic films disclosed in Engfeldt with the similar methods of charging/discharging electrochromic films of Pradhan for multiple reasons. (EX1003, ¶143.)

First, a POSA would have understood Pradhan to provide specific techniques for controlling the charging/discharging of electrochromic films that could be incorporated into and/or used to modify Engfeldt's existing charging framework to better control charging/discharging from one optical state to another desired optical state. (*Id.*, ¶143.) A POSA would have been motivated to use Pradhan's well-known techniques of using current, or both voltage and current, to improve charging/discharging of electrochromic films as part of Engfeldt's charging/discharging operation when voltage-based charging alone was too slow or risked operating the device under undesirable or damaging conditions. (*Id.*, ¶145.) This would have achieved predictable results of better charging/discharging control and performance. (*Id.*, ¶146.)

Second, a POSA would have been motivated to combine Engfeldt with Pradhan to incorporate Pradhan's well-known methods of using current, or a

combination of both voltage and current, to predictably improve Engfeldt's switching or transition speed between optical states when voltage-based charging alone is insufficient. (EX1003, ¶144.) Engfeldt expressly recognizes a speed-voltage tradeoff, explaining that "it is of benefit if the intended charging voltage for a static state is relatively large, since this typically increases the charging speed. However, the charging voltage for a static state cannot be too high without damaging the device." (EX1004, 14:6-11.) Thus, Engfeldt acknowledges the desire for faster switching between optical states, while also recognizing that simply increasing voltage is not always an acceptable solution. (EX1003, ¶144.)

A POSA would recognize that Pradhan provides a well-known solution to that same problem. (*Id.*, ¶145.) Specifically, Pradhan teaches that during the voltage drive, "when it is determined that the transition is not progressing sufficiently fast, the transition switches to a mode where it is driven by an applied current," and that the current is selected so it is "sufficiently great to increase the speed of the transition but is not so great that it degrades or damages the electrochromic device." (EX1005, [0172].) A POSA would have understood this teaching to improve Engfeldt's method of charging/discharging electrochromic films, and to yield the predictable result of faster or more efficient charging/discharging. (EX1003, ¶145.) Rather than relying only on increased voltage to accelerate charging, a POSA would readily recognize that Engfeldt could switch to current driving as taught by Pradhan during

the transition when faster charging/discharging is needed, while still using charge feedback to avoid damaging the device. (*Id.*)

That modification would have been technically straightforward and would have yielded a predictable result. (EX1003, ¶146.) Engfeldt already teaches driving the transition from one optical state to another with voltage using controller-based transition management, and recognizes the desirability of increasing charging speed without damaging the electrochromic film due to over-voltage. Pradhan teaches one or more ways of doing so. Indeed, Pradhan confirms that voltage control and current control were known, interchangeable implementation options, explaining that the controller may increase or decrease current rather than voltage and that, “[w]hether voltage or current is controlled by the hardware . . . the algorithm attains the desired result.” (*Id.*, [0083].) A POSA therefore would have been motivated to incorporate Pradhan’s use of voltage driving and current driving into Engfeldt’s charging/discharging method in order to accelerate the transition without relying solely on higher applied voltage. (EX1003, ¶146.)

Third, a POSA would have been motivated to incorporate Pradhan’s well-known probing-based feedback techniques into Engfeldt’s final-stage optical transition control to improve endpoint control as the optical transition approaches its desired state. (*Id.*, ¶147.) Engfeldt explains that “[w]hen coming closer to the intended final transmittance condition, the static state operation might be

experienced as a somewhat coarse charging method.” (EX1004, 17:1-16.) Engfeldt thus identifies the importance of final stage control of charging/discharging. As one solution, Engfeldt introduces a “trickle” substate using a voltage trickle charge to adjust the film’s charge “in small amounts, to slowly approach the final transmittance.” (*Id.*, 17:29-18:5.) Engfeldt thus recognizes that final-stage control can be difficult and that a more refined technique is desirable as the device nears the endpoint of the optical transition. (EX1003, ¶147.)

Pradhan also identifies the importance of final stage control of charging/discharging electrochromic films, and explains the same practical endpoint-control problem: “it can be difficult to predict how long the applied drive voltage should be applied before transitioning to the hold voltage” because device size, fabrication differences, and environmental conditions can all affect transition behavior. (EX1005, [0117].) Pradhan further explains that pre-determining different drive times for many different devices can be “tedious, expensive, and time-consuming” (*Id.*, [0118].) Pradhan accordingly employs the well-known probing technique that “involves pulsing the current or voltage applied to drive the transition and then monitoring the current or voltage response to detect an overdrive condition,” including “pulsing the applied drive voltage by dropping it to the level of the hold voltage . . . and monitoring the current response.” (*Id.*, [0121]-[0122].) When the response reaches a threshold, “the device control system determines that

it is now time to transition from the drive voltage to the hold voltage.” (*Id.*, [0122]. EX1003, ¶148.)

Given Pradhan’s similar electrochromic system, a POSA would have applied Pradhan’s techniques for improved control to improve Engfeldt’s endpoint charging/discharging of electrochromic films. (EX1003, ¶148.) Rather than relying only on Engfeldt’s comparatively “coarse” final-stage charging logic and trickle charge adjustments, a POSA would have supplemented with and/or substituted Pradhan’s pulsing-and-monitoring technique to assess, in real time, whether the electrochromic transition had progressed far enough to shift from stronger driving conditions to more refined charging/discharging as the transition approaches its desired optical state. (EX1003, ¶148.) The combination would take advantage of Pradhan’s improved measured electrical-response feedback to refine the point at which Engfeldt changes charging behavior near the endpoint, thereby improving final-state control in a predictable and technically sensible manner. (EX1003, ¶148.)

Fourth, a POSA would have been motivated to incorporate Pradhan’s known current-feedback safety logic into Engfeldt’s existing charging controller so that Engfeldt’s measured charging current could be used to limit damaging operating conditions during electrochromic transitions. (EX1003, ¶149.) Engfeldt expressly warns that, although higher charging voltage can increase switching speed, “the charging voltage for a static state cannot be too high without damaging the device.”

(EX1004, 14:6-13.) Engfeldt also discloses hardware for measuring current during operation, including a “current meter 42” configured to “measure a charging current.” (*Id.*, 22:6-15.) Thus, Engfeldt already recognizes the risk of damage during charging and already includes current-sensing capability within its control architecture. (EX1003, ¶149.)

Pradhan provides a direct and concrete way to address that same concern. Pradhan teaches that “[i]f the current or voltage supplied to a device is too great, it can cause damage to the device,” and that “electrical feedback is used to ensure that the optically switchable device is maintained within a safe window of operating conditions.” (EX1005, [0061].) Pradhan further explains that where “the measured current is above I_{safe} ,” the controller should “decrease voltage (or rate of increase in the voltage) in order to bring the current below I_{safe} ,” and that the controller may “actively monitor current and voltage” and “quickly adjust the applied voltage to ensure that the current remains below I_{safe} during the entire controlled current phase of the transition.” (*Id.*, [0081]-[0082].) (EX1003, ¶150.)

A POSA would have understood this teaching to provide a specific enhancement to Engfeldt’s charging process: using the charging current already measured by Engfeldt’s current meter as feedback to adjust the applied voltage, or the rate at which voltage is increased, when the current indicates that the device is entering an unsafe operating region. (EX1003, ¶150.) That modification would have

been straightforward because Engfeldt already measures charging current and already seeks to avoid damage from excessive voltage. Incorporating Pradhan's feedback-based safety logic into Engfeldt's controller would therefore have predictably improved protection of the electrochromic device during faster or more aggressive charging without requiring any departure from Engfeldt's basic control framework. (*Id.*, ¶150.)

Fifth, a POSA would have understood that there are a small and finite number of ways to drive charging/discharging of an electrochromic film by inserting or removing electric charge: voltage-based driving, current-based driving or both. (*Id.*, ¶153.) A POSA would have likewise understood that there are a limited and finite number of ways to apply and control voltage or current to the system, either constant/continuous or pulsed. (*Id.*). A POSA would also have understood that selecting among those well-known and limited driving and control options depends on the characteristics and operating requirements of the electrochromic device, including desired transition speed, endpoint precision, and avoidance of damage. (*Id.*) Pradhan's teachings regarding voltage driving, current-driving, combining voltage driving and current driving, using pulsed power, and feedback-based safety control would have presented a known, limited and predictable set of options for improving Engfeldt's existing controller-based charging framework. (*Id.*, ¶153.) A POSA therefore would have been motivated to combine Engfeldt with Pradhan to

incorporate those teachings as routine selection and adaptation of known electrochromic control techniques to achieve a predictable balance of switching speed, control refinement, and safe operation. (*Id.*)

C. Reasonable Expectation of Success

A POSA would have had a reasonable expectation of success in combining Engfeldt's voltage-driven electrochromic film charging/discharging methods with Pradhan's well-known feedback-based transition-control techniques that employ voltage, current, combinations of voltage and current, as well as different types of constant and pulsed power sources to charge/discharge electrochromic films. (EX1003, ¶¶154-156) Both references are directed to controlling charging/discharging using measured electrical characteristics during electrochromic film transitions, and both rely on the same general types of electrical inputs, sensing, and controller-directed adjustment of charging behavior. Pradhan's teachings therefore would have been applied as targeted enhancements to Engfeldt's existing controller—e.g., including current driving when voltage driving to charge/discharge the electrochromic film is too slow or imprecise, using probing-based feedback to refine endpoint control, and using measured current to keep the device within safe operating conditions. (*Id.*, ¶155.)

Because those modifications are structurally and functionally consistent with Engfeldt's existing control architecture, implementing them would have required

only routine adaptation of controller logic and ordinary programming/configuration work as well-known to a POSA to achieve predictable results, rather than any significant modification of Engfeldt's system. (*Id.*) A POSA therefore would have reasonably expected success that the combination would operate predictably and improve transition control to achieve the common objectives shared by Engfeldt and Pradhan described above. (EX1003, ¶156; EX1004, 14:6-13, 17:15-18:5, 22:6-15; EX1005, [0061], [0081]-[0082], [0117]-[0122], [0172].)

D. Claim Element Analysis

1. Claim 3

Pradhan teaches driving optical transition by applying an external DC current to the electrochromic film. (EX1003, ¶¶157-162.) Pradhan teaches that, when feedback indicates that a voltage-driven transition “is not progressing sufficiently fast,” the controller may switch to “a mode where it is driven by an applied current,” with the current chosen to be “sufficiently great to increase the speed of the transition but . . . not so great that it degrades or damages the electrochromic device.” (EX1005, [0172].) Thus, Pradhan expressly teaches using applied current as the driver for inserting/extracting electric charge to accelerate an electrochromic transition while avoiding damage. (EX1003, ¶158.) And, because Pradhan discloses that the electrochromic device is connected to an “external DC power source,” a POSA

would have understood that Pradhan applies external DC current to drive the optical transition. (EX1005, [0172], [0257]-[0258]; EX1003, ¶159.)

As explained above in section VI.B., a POSA would have been motivated to incorporate Pradhan's use of current driving into Engfeldt's voltage-driven control framework to address Engfeldt's recognized speed-versus-damage tradeoff—*i.e.*, Engfeldt's recognition that higher charging voltage increases charging speed, but can run the risk of damaging the device. (EX1004, 14:6-11; EX1005, [0172]; EX1003, ¶160.) In addition to voltage, a POSA would thus have known to use the external DC charging current as taught by Pradhan and was well-known in the art to charge/discharge the electrochromic film to achieve the shared Engfeldt/Pradhan objective of increased optical transition speed and increased control without damaging the electrochromic device. (EX1003, ¶161.)

2. Claim 6

While Engfeldt teaches using voltage as the driving force to charge/discharge the electrochromic film as explained above in Ground 1, Pradhan teaches using voltage driving, current driving or both to charge/discharge the electrochromic film. (EX1005, [0006].) Pradhan not only teaches supplementing an applied voltage-drive mode with an applied-current drive mode, Pradhan teaches using both voltage and current as the applied driving forces to charge/discharge the electrochromic film from one optical state to another. (EX1005, [0172].) In particular, Pradhan explains

that, the controller may be configured to increase the drive voltage as appropriate to speed up transition from a first optical state to a desired second optical state. (*Id.*) When feedback indicates the transition “is not progressing sufficiently fast,” the transition may switch to “a mode where it is driven by an applied current.” (*Id.*) Pradhan teaches selecting the applied current so that “the current is sufficiently great to increase the speed of the transition but it is not so great that it degrades or damages the electrochromic device.” (*Id.*) Pradhan teaches using probing techniques in which the controller pulses the current or voltage applied to drive the transition and monitors the electrical response to determine transition progress and when to alter drive conditions. (*Id.*, [0121]-[0122]; see also [0171]-[0172], [0142].) Thus, Pradhan teaches injecting electric charges into the electrochromic film using a combination of both external applied voltage and external applied current. (EX1003, ¶¶163-165.)

As explained above in Section VI.B., a POSA would have been motivated to incorporate Pradhan’s combination of voltage driving and current driving into Engfeldt’s existing voltage-driven charging framework to improve transition speed when voltage-based charging/discharging alone is insufficient, and to refine control of the transition as the device approaches its desired optical state. (EX1003, ¶166.) More specifically, a POSA would have understood that Engfeldt’s controller could continue to apply external voltage during charging, while also using Pradhan’s current driving mode during portions of the optical transition to increase the speed

of the transition and/or refine control of the optical transition to avoid degrading or damaging the electrochromic device. (*Id.*) The resulting combination therefore would have resulted in injecting electric charges into the electrochromic film using a combination of an external voltage and an external current to inject/extract electric charges into electrochromic film as recited by claim 6. (*Id.*, ¶167.)

3. Claim 10

See Ground 2, Claim 3 above. (Section VI.D.1; EX1003, ¶169.)

4. Claim 13

See Ground 2, Claim 6 above. (Section VI.D.2.) *See also* [8.2] regarding Engfeldt's teachings applying to both extracting and injecting. (EX1003, ¶170.)

5. Claim 17

See Ground 2, Claims 3 and 6 above (Sections VI.D.1-2) regarding Engfeldt and Pradhan's combined teaching rendering obvious the concept of adjusting the amount of electric charges within the electrochromic film by applying the current driving, and the current driving including an external DC current. (EX1003, ¶171.)

6. Claim 18

See Ground 2, Claim 6 above. (Section VI.D.2; EX1003, ¶172.)

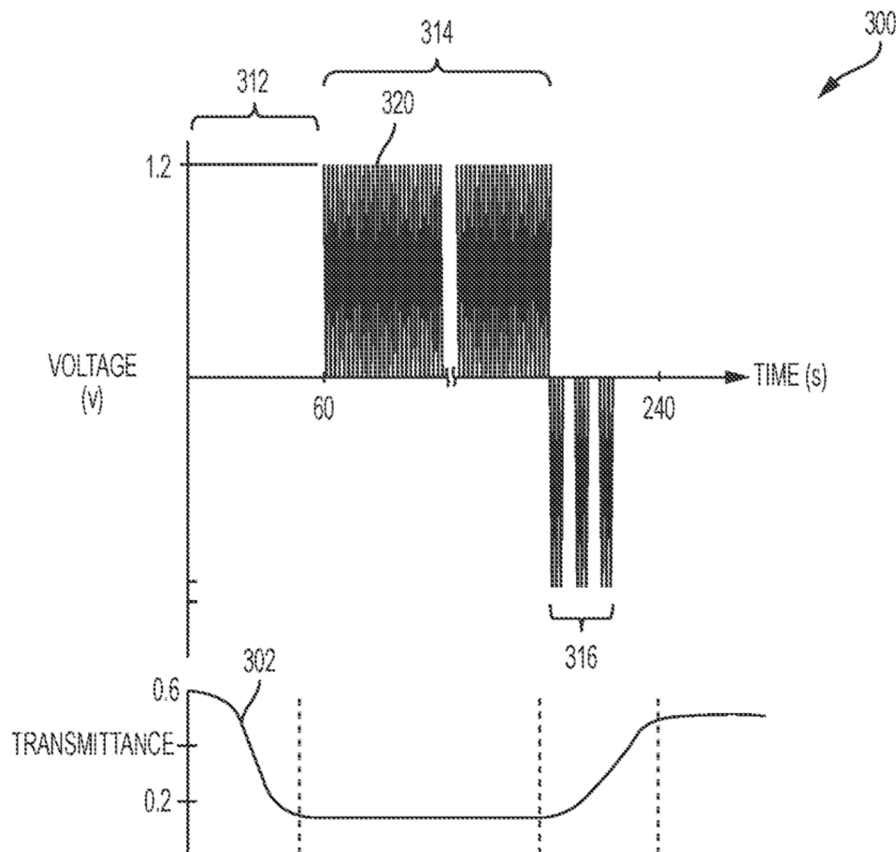
**VII. GROUND 3: CLAIMS 3-5, 7, 10-12, 14, AND 16-17 ARE OBVIOUS
OVER ENGFELDT IN VIEW OF DUARTE**

A. Overview of Duarte

Similar to both Engfeldt and Pradhan, Duarte is directed to “controlling electrochromic panels, which lighten and darken in response to applied electric current and/or voltage.” (EX1006, 1:6-10; Abstract; EX1003, ¶173.) Specifically, Duarte is directed to controller-based techniques for controlling the optical transmittance of the electrochromic panel by causing a power supply to apply voltage and/or current to the panel according to a “predetermined pattern.” (*Id.*, Abstract.) These “predetermined patterns” of voltage and/or current can include repeated electrical pulses,” also referred to by Duarte as “micro-pulses.” (*Id.*, 4:42-44.) By utilizing these micro-pulses, “the energy in an electrochromic system is increased with faster color change (both during darkening and lightening) without damaging the electrochromic materials contained in the panels.” (*Id.*, 4:42-47.) Pulses of greater magnitude may be used which would otherwise damage system components. (*Id.*, 4:54-58.) (EX1003, ¶174.)

Duarte contemplates applying voltage, current or both continuously or as a repeating series of pulses. (*Id.*, 7:56-8:10; 9:25-51, 13:61-14:10.) Duarte’s micro-pulses “can be interspersed ... between periods in which a voltage is applied substantially continuously.” (*Id.*, 9:35-51.) Duarte’s controller causes an external power supply to deliver continuous or pulsed voltage and/or current to darken or

lighten an electrochromic panel. (*Id.*; see also 12:11-31.) As one example shown in Fig. 3, voltage is first applied continuously (312) and then as a series of micro pulses (314) to achieve a darkened state. (*Id.*, 10:10-25.) Duarte then transitions the electrochromic panel to a lightened state by a series of negative voltage pulses (316). (EX1006, 10:26-40; EX1003, ¶¶175-176.)



EX1006, Figure 3

The combination of continuous or constant voltage and/or current with micro-pulsing yields the best of both worlds: continuous charging/discharging helps quickly drive the panel to the desired darkened state, while micro-pulses can be

interspersed with continuous power supply to better control charge delivery and prevent damaging the electrochromic materials. (EX1006, 4:42-47, 9:35-39; EX1003, ¶177.)

B. Motivation to Combine Duarte with Engfeldt

A POSA would have been motivated to combine Engfeldt's methods of charging/discharging electrochromic films with Duarte's similar controller-based techniques for charging/discharging electrochromic films for multiple reasons. (EX1003, ¶178.) The reasons are similar to those for combining Engfeldt and Pradhan. In particular, a POSA would have understood Duarte to provide specific pulse-based control techniques that could be incorporated into and/or used to modify Engfeldt's existing charging framework to better control charging/discharging from one optical state to another desired optical state. (*Id.*, ¶178.) For example, a POSA would have been motivated to use Duarte's well-known continuous and pulsed drive techniques to improve transition speed, refine control of charge delivery during the optical transition, and reduce the likelihood of damaging the electrochromic device during faster switching. (*Id.*) This would have achieved predictable results of better charging/discharging control and performance. (*Id.*)

First, a POSA would have been motivated to combine Engfeldt with Duarte to improve Engfeldt's switching or transition speed between optical states without relying solely on higher continuously applied voltage. (EX1003, ¶179.) Engfeldt

expressly recognizes a speed-voltage tradeoff, explaining that “it is of benefit if the intended charging voltage for a static state is relatively large, since this typically increases the charging speed. However, the charging voltage for a static state cannot be too high without damaging the device.” (EX1004, 14:6-11.) Thus, Engfeldt acknowledges the desire for faster switching between optical states, while also recognizing that simply increasing voltage is not always an acceptable solution. (EX1003, ¶179.)

A POSA would recognize that Duarte provides a well-known solution to that same problem. (EX1003, ¶180.) Duarte teaches that micro-pulses may be used such that “the energy in an electrochromic system is increased with faster color change (both during darkening and lightening) without damaging the electrochromic materials contained in the panels.” (EX1006, 4:42-47.) Duarte further teaches that pulses of greater magnitude may be used that otherwise could damage system components. (*Id.*, 4:54-58.) A POSA would have understood this teaching to improve Engfeldt’s method of charging/discharging electrochromic films, and to yield the predictable result of faster or more efficient charging/discharging without relying solely on increasing the amplitude of the voltage. (EX1003, ¶180.)

Second, a POSA would have been motivated to incorporate Duarte’s techniques for pulsing power into Engfeldt’s transition-control framework to refine charging/discharging control as the electrochromic film moves toward its desired

optical state. (EX1003, ¶181.) Engfeldt explains that, “[w]hen coming closer to the intended final transmittance condition, the static state operation might be experienced as a somewhat coarse charging method,” and introduces a “trickle” substate to adjust the film’s charge “in small amounts” as the device approaches the final transmittance. (EX1004, 17:1-18:5.) Engfeldt thus recognizes that a single, static charging mode may not always provide the desired degree of control throughout the transition. (EX1003, ¶181.)

Duarte expands on that same general approach. Duarte teaches that the controller may apply voltage and/or current according to a “predetermined pattern” comprising “pulses, micro-pulses, and/or periods of continuous voltage and/or current,” and that micro-pulses may be interspersed between periods in which voltage is applied substantially continuously. (EX1006, Abstract, 9:35-51.) A POSA would have understood these teachings to allow the controller to deliver charge in smaller, spaced increments, rather than only through a continuous application of power, thereby giving the controller more flexibility to shape how the transition progresses. (EX1003, ¶182.) In that way, Duarte would have supplied a specific enhancement to Engfeldt’s existing control logic by enabling more granular modulation of the applied voltage/current driving force during the transition. (*Id.*)

Finally, a POSA would have understood that there are a limited and predictable number of ways to deliver external electrical drive to an electrochromic

film during a transition, including substantially continuous drive, pulsed drive, or combinations of the two. (EX1003, ¶183.) A POSA would likewise have understood that selecting among those known control options depends on the operating requirements of the electrochromic device, including desired transition speed, control refinement, and avoidance of damage. (*Id.*) In that context, Duarte's teachings regarding predetermined pulse patterns, interspersed micro-pulses, and continuous-and-pulsed drive would have presented a known and predictable set of implementation options for improving Engfeldt's existing controller-based charging framework. A POSA therefore would have been motivated to incorporate those teachings into Engfeldt as routine selection and adaptation of known electrochromic control techniques to achieve a predictable balance of switching speed, control refinement, and safe operation. (*Id.*)

C. Reasonable Expectation of Success

Engfeldt already includes the electrical-control infrastructure needed to implement such a modification. Engfeldt teaches a charge control arrangement that applies the main charging/discharging voltage, measures charging current, and measures open-circuit voltage for use in controlling transition between optical states and approaching a target coloring level. (EX1004, 15:29-16:4, 22:6-15.) Duarte teaches that the same type of controller-based electrochromic system may apply the electrical drive according to predetermined patterns including pulses, micro-pulses,

and periods of substantially continuous voltage and/or current, including micro-pulses interspersed between periods of continuous application. (EX1006, 4:42-47, 9:35-51.) A POSA therefore would have understood that implementing Duarte's teachings in Engfeldt would have involved only routine adaptation of controller logic and ordinary programming of Engfeldt's existing control electronics to vary the timing and profile of the applied drive during a transition, rather than any unpredictable redesign of the underlying electrochromic device. (EX1003, ¶¶184-185.)

A POSA also would have reasonably expected that modification to succeed because Duarte expressly teaches that its use of pulsed power to charge/discharge electrochromic films provides performance benefits in the same technological context, including allowing the electrochromic system to achieve faster color change without damaging the electrochromic materials, and permitting use of pulses of greater magnitude that otherwise could damage system components. (EX1006, 4:42-58.) Given Engfeldt's existing controller-based charging architecture and Duarte's express teaching that pulsed power can improve optical transition in electrochromic films, a POSA would have expected Duarte's method of applying pulsed power to operate predictably when implemented in Engfeldt's system and to provide the same type of benefits taught by Duarte. (EX1003, ¶¶186-187.)

D. Claim Element Analysis

1. Claim 3

As explained in Ground 1 (Section V.B.1.), Engfeldt teaches a method of charging/discharging an electrochromic film by injecting/extracting electric charge into/from the film. Although Engfeldt primarily describes voltage-driven embodiments, a POSA would have understood Engfeldt's voltage-driven charging/discharging framework to be compatible with a current-driven charging/discharging framework because transitioning between optical states involves driving electric charge into and out of the electrochromic material. (EX1003, ¶188.) POSAs in the field had long understood that process could be characterized and controlled using either applied voltage, applied current, or both depending on the device architecture and control objectives. (*Id.*, ¶37.) Thus, a POSA would have understood voltage control and current control to be established and conventional alternatives for driving electrochromic transitions, including through application of external DC current. (*Id.*, ¶¶188-189.)

Duarte drives that point home. Duarte is directed to “controlling electrochromic panels, which lighten and darken in response to applied electric current and/or voltage,” and even repeatedly explains that its “electronic circuitry may be configured to adjust a voltage and/or current applied to an electrochromic panel.” (EX1006, 8:56-63; *see also* Abstract, 1:6-10, 1:32-36, 1:42-47, 1:51-54,

1:56-64, 2:1-17, 2:47-50, 4:12-14, 4:32-35, 5:1-4, 8:11-19, 8:56-63, 9:40-10:2, 10:24-25, 10:40-43, 11:55-60, 12:1-10, 14:6-10.) Duarte repeatedly teaches that electrochromic transition may be driven using voltage, current, or both. (*Id.*) In its explanation of darkening control, Duarte further teaches current-based driving: while “positive and/or negative voltage can be applied to the panel” as various waveforms, “[s]uch waveforms could also be applied as a controlled current to the system and/or panel.” (EX1006, 13:61-67.) A POSA therefore would have understood Duarte to teach that the same type of electrochromic transition control described in voltage terms could be implemented using controlled external current. (EX1003, ¶189-190.)

A POSA would have found it obvious to modify Engfeldt’s electrochromic film charging/discharging framework to use current driving in view of Duarte. EX1003, ¶191.) Both references concern controller-based electrochromic systems in which external power drives charging/discharging of the electrochromic film to transition between optical states. Engfeldt already measures charging current and uses electrical feedback to control the transition, while Duarte expressly teaches driving the electrochromic transition between optical states by applying current as well as voltage. (EX1004, 15:29-33, 22:6-15; EX1006, 1:6-10, Abstract, 13:61-67.) Further, voltage-controlled operation and current-controlled operation were established and conventional electrochromic control approaches known in the art for

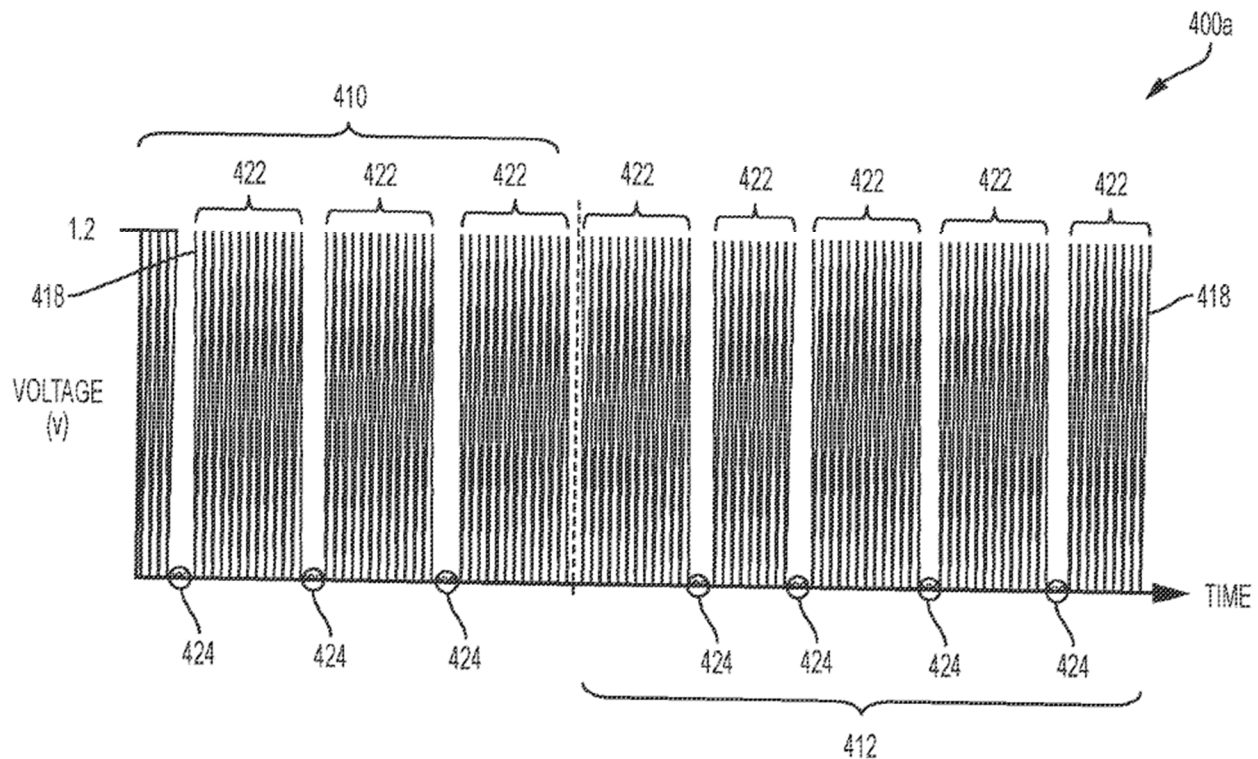
decades, and a POSA would have regarded selection between them as a routine implementation choice based on device architecture and control objectives. (EX1003, ¶192.) A POSA therefore would have understood that application of external DC current is a technically compatible and predictable alternative implementation of Engfeldt’s voltage-driven charging/discharging framework. The resulting combination therefore would have rendered claim 3 obvious. (*Id.*)

2. Claim 4

Duarte discloses using pulsed voltage to drive the electrochromic transition. In particular, Duarte teaches that a controller causes an external power supply to apply voltage and/or current to the electrochromic film according to a “predetermined pattern,” and that such patterns can include repeated electrical pulses, i.e., “micro-pulses.” (EX1006, Abstract, 4:42-44.) A POSA would have understood these disclosures to teach applying external pulsed voltage to the electrochromic film to drive the optical transition. (EX1003, ¶193.)

Duarte’s Figure 4 illustrates an example of using pulsed voltage to drive optical transition of an electrochromic film. Voltage profiles 400a includes “a first portion 410 including an applied voltage in the positive polarity, which causes darkening of the panel 10.” (EX1006, 10:54-60.) As shown below, the first portion 410 “includes groups 422 of positive voltage micro-pulses 418.” (*Id.*, 10:60-64.) A POSA therefore would have understood Duarte to teach using external pulsed

voltage to drive charging/discharging of an electrochromic film to transition between optical states. (EX1003, ¶194.)



EX1006, Figure 4A

It would have been obvious to a POSA to incorporate Duarte's pulsed-voltage driving technique into Engfeldt's controller-based charging framework because Engfeldt recognizes that increasing applied voltage can increase charging speed, but that the voltage cannot be too high without damaging the device. (EX1004, 14:6-11; EX1003, ¶195.) Duarte teaches a specific solution to that same problem, explaining that use of micro-pulses increases the rate of charging/discharging the electrochromic film "with faster color change" "without damaging the

electrochromic materials contained in the panels,” and further that pulses of greater magnitude may be used that otherwise could damage system components. (EX1006, 4:42-58.) A POSA therefore would have been motivated to modify Engfeldt to incorporate Duarte’s pulsed-voltage driving technique to achieve faster electrochromic transition while reducing the risk of damage, as discussed in Section VII.B. (EX1003, ¶195.) The resulting combination therefore would have rendered claim 4 obvious. (*Id.*)

3. Claim 5

As explained above with respect to claim 3, it would have been obvious to modify Engfeldt’s electrochromic charging framework to use external current driving in view of and as taught by Duarte. Duarte also expressly teaches that its controller may apply a “predetermined pattern” of “voltage and/or current,” and that this predetermined pattern may include “pulses” or “micro-pulses.” (EX1006, Abstract, 9:40-55, 4:42-44, 5:10-14, 9:25-32.) A POSA therefore would have understood the combination of Engfeldt and Duarte to teach driving charging/discharging an electrochromic film with current by applying an external pulsed current to the electrochromic film. (EX1003, ¶¶196-197.)

For the same reasons discussed above for claim 3, a POSA would have found it obvious to incorporate Duarte’s pulsed-current implementation into Engfeldt’s controller-based electrochromic charging framework. Doing so would have been a

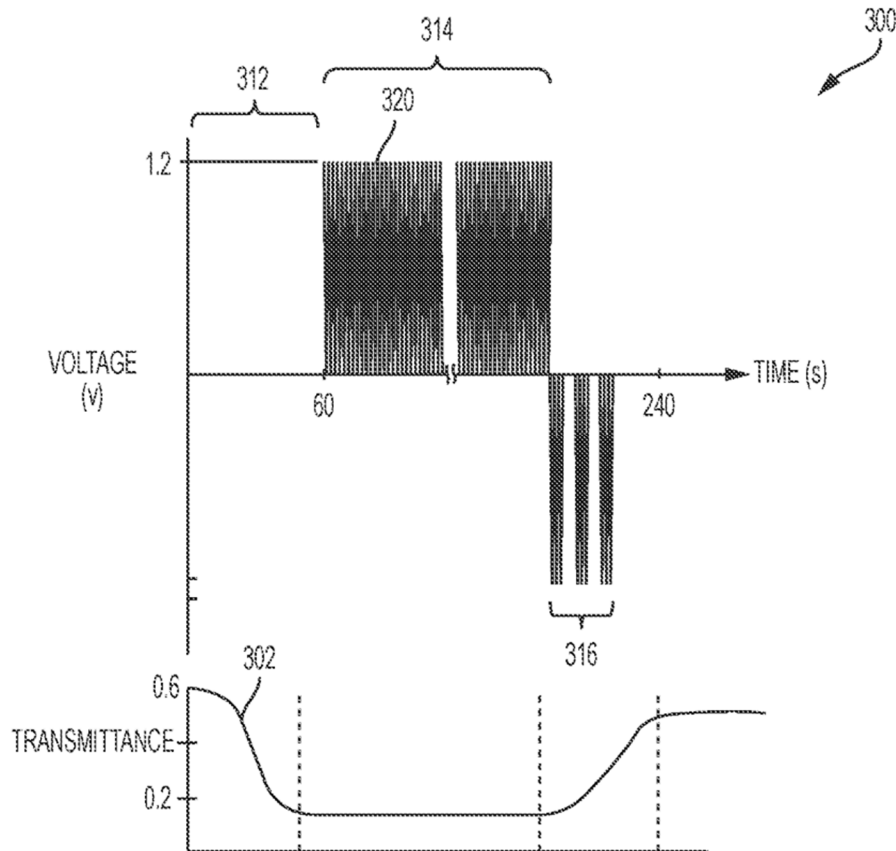
technically compatible and predictable modification of the same current-driving approach already discussed for claim 3, with the further benefit taught by Duarte that pulsed drive can improve transition performance without damaging the electrochromic materials. (Section VII.B.-C.; EX1006, 4:42-47; EX1003, ¶198.) The resulting combination therefore would have rendered claim 5 obvious. (EX1003, ¶199.)

4. Claim 7

As explained in Ground 1, this limitation would have been obvious in view of Engfeldt alone. (*See* Section V.B.4; EX1003, ¶200.)

Claim 7 is also obvious over Engfeldt in view of Duarte. Duarte teaches that its controller can cause the power supply to apply voltage and/or current to the electrochromic panel according to a “predetermined pattern” that can include both “repeated electrical pulses” (*i.e.*, “micro-pulses”) and periods in which voltage and/or current are applied substantially continuously. (EX1006, Abstract, 4:42-61, 9:25-55, 10:10-14, 10:21-24.) Specifically, “micro-pulses can be interspersed between periods of longer duration pulses or periods in which a voltage is applied substantially continuously.” (*Id.*, 9:35-39.) A POSA would understand Duarte to disclose applying a combination of a constant power and a pulsed power to the electrochromic film. (EX1003, ¶200.)

Duarte's FIG. 3 provides an example. As shown below, "a voltage profile 300 includes a first portion 312 for causing the panel to darken (e.g., to transition from a lightened or bleached state to a darkened state)." (*Id.*, 10:3-5.) The voltage applied during this first portion is "a continuous positive voltage." (*Id.*, 10:6-13.) Voltage is then applied as a series of micro pulses (314) to achieve a darkened state. (*Id.*, 10:10-25.) Additionally, since Duarte teaches "interspersing" the micro-pulses between the continuous voltage, a POSA would have understood that the "continuous positive voltage" applied during the first portion 312 can include interspersed micro-pulses. Duarte confirms this: "As shown in FIG. 3, a continuous positive voltage of 1 minute in duration is applied in the first portion 312; however, *micro-pulses or longer duration pulses could also be applied.*" (*Id.*, 10:6-13) (emphasis added). (EX1003, ¶201.)



EX1006, Figure 3

A POSA would have therefore understood Duarte to disclose applying a combination of constant and pulsed power to inject/remove electric charges into/from the electrochromic film. (EX1003, ¶202.) As explained in Section VII.B (Motivation to Combine Duarte with Engfeldt), it would have been obvious to implement Duarte's teachings of combined constant and pulsed voltage into Engfeldt's method of applying voltage during the main charging/discharging operation to better control injection/removal of charge, to increase speed and to reduce the potential for damage during the optical transitions. (*Id.*, ¶202-203.)

5. Claim 10

See claim 3 above. (Section VII.D.1.) (EX1003, ¶205.)

6. Claim 11

See claim 4 above. (Section VII.D.2.) (EX1003, ¶206.)

7. Claim 12

See claim 5 above. (Section VII.D.3.) (EX1003, ¶207.)

8. Claim 14

See claim 7 above. Section VII.D.4. *See also* [8.2] regarding Engfeldt's teachings applying to both extracting charge from and injecting charge into an electrochromic film. (Section V.B.5.c; EX1003, ¶208.) The same is true for Duarte: applying a positive voltage and/or current darkens the panel, and applying a negative voltage and/or current lightens the panel. (EX1006, 8:11-27.) A POSA would understand that applying a positive voltage/current "injects" charge into the electrochromic film, while applying a negative voltage/current "extracts" charge from the electrochromic film. (EX1003, ¶209.)

9. Claim 16

Duarte teaches adjusting the amount of electric charges in the electrochromic film by applying a external pulsed voltage. *See* claim 4 (Section VII.D.2.) (EX1003, ¶210.)

10. Claim 17

Regarding “wherein adjusting the amount of electric charges within the electrochromic film comprises applying the current driving, the current driving including an external DC current,” see claim 3. (Section VII.D.1.) Regarding “the current driving including... an external pulsed current,” see claim 5. (Section VII.D.3.) (EX1003, ¶211.)

VIII. GROUND 4: CLAIM 19 IS OBVIOUS OVER ENGFELDT IN VIEW OF PRADHAN AND DUARTE

A. Claim 19

As explained above for claim 18 (Section VI.D.6.), Engfeldt and Pradhan teach adjusting the amount of electric charges within the electrochromic film by applying a combination of external voltage and external current. (EX1004, 15:29-33.) (EX1005, [0083], [0172].) Claim 19 specifies that the external voltage includes DC voltage and pulsed voltage, and the external current includes DC current and pulsed current. Duarte teaches that additional limitation. (EX1003, ¶212.)

Duarte teaches a controller-based electrochromic system in which a power supply applies “voltage and/or current” according to a predetermined pattern comprising “pulses, micro-pulses, and/or periods of continuous voltage and/or current.” (EX1006, Abstract, 9:25-51.) Duarte further teaches that micro-pulses may be interspersed between periods in which voltage is applied substantially continuously. (EX1006, 9:35-39, 49-51.) Duarte also explains, in connection with

Figure 3, that a continuous positive voltage may be applied during one portion of the transition and that the positive voltage may be applied “continuously or periodically,” for example, “as a series [of] micro-pulses.” (EX1006, 9:58-10:21.) Duarte further applies these same continuous and pulsed power teachings to driving the optical transitions with current, explaining that “[a]s will be appreciated by those skilled in the art”, various pulsed waveforms “can be applied as a controlled current to the system and/or panel” and the “different waveforms can be combined together to generate unique voltage and/or current patterns or profiles.” (*Id.*, 13:61-14:10; EX1003, ¶213.)

Duarte teaches that these pulsed-control techniques provide “faster color change” “without damaging the electrochromic materials.” (EX1006, 4:42-47.) A POSA would have understood these teachings to disclose that electrochromic transition control may use both continuous DC driving force and pulsed driving force, and that Duarte’s control architecture contemplates voltage-controlled driving forces, current-controlled driving forces, or both, because Duarte repeatedly describes the driving force injecting/extracting electric charge into/from the electrochromic film as “voltage and/or current.” (EX1006, Abstract, 1:6-10, 1:32-36, 1:42-47, 1:51-54, 2:1-17, 4:12-14, 8:11-19, 8:56-63, 9:35-51, 9; EX1003, ¶¶213-215.)

A POSA would have been motivated to modify the Engfeldt/Pradhan combination to incorporate Duarte's method of applying voltage and/or current to drive adjustments to the electric charge applied to the electrochromic film in both continuous and pulsed manners. (EX1003, ¶216.) Engfeldt and Pradhan already teach a controller-based electrochromic charging framework using both voltage and current, while Duarte provides a specific and compatible way to use both constant/DC and pulsed voltage and current to improve transition speed, refine control, and reduce the risk of damage. (*Id.*, ¶216.) Engfeldt recognizes that increasing applied voltage can increase charging speed, but warns that the voltage cannot be too high without damaging the device. (EX1004, 14:6-11.) Pradhan likewise teaches using voltage drive and current drive to improve transition performance while avoiding degradation or damage. (EX1005, [0061], [0083], [0172].) Duarte supplies a predictable enhancement to that same framework by teaching that the driving force to charge/discharge an electrochromic film – both voltage and current - may be delivered in substantially continuous DC form, in pulsed form, or as a combination of the two during an optical transition. (EX1006, Abstract, 4:42-47, 9:35-39, 49-51, 9:58-10:21.) Because all three references use controller-based applications to inject/extract electrical charge into/from an electrochromic device to reach a desired optical state, applying Duarte's teachings to use both constant and pulsed external power to the combination of voltage and

current driving already taught by Engfeldt and Pradhan would have been a straightforward and technically sensible modification. (EX1003, ¶217.)

Accordingly, a POSA would have found it obvious to combine Duarte's teachings with the Engfeldt/Pradhan system such that the applied voltage and the applied current are each delivered as combinations of continuous/DC and pulsed forms, and as claim 19 requires. (EX1003, ¶218.)

IX. MANDATORY NOTICES UNDER 37 C.F.R. § 42.8

A. Real Party-In-Interest — 37 C.F.R. § 42.8(b)(1)

Petitioner, Ambilight Inc, is the real party-in-interest.

B. Related Matters — 37 C.F.R. § 42.8(b)(2)

Petitioner is not aware of any civil actions involving the '851 Patent, or any disclaimers, reexamination certificates or other petitions for *inter partes* review for the '851 Patent.

C. Lead and Back-Up Counsel Under 37 C.F.R. § 42.8(b)(3)

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D. Service Information Under 37 C.F.R. § 42.8(b)(4)

Please address all correspondence/service to all counsel listed above.

Petitioner consents to service by email directed to:

Ambilight@dickinson-wright.com.

X. SERVICE

Petitioner will serve the Petition, Power of Attorney, and supporting evidence on the Patent Owner's correspondent attorney of record as listed on USPTO Patent Center. A certificate of service is attached at the end of this Petition, pursuant to 37 C.F.R. § 42.6(e)(4)(i).

XI. FEES

The required fees are submitted herewith. If any additional fees are due at any time during this proceeding, the Patent Office is authorized to charge such fees to Deposit Account No. 04-1061.

Dated: May 18, 2026

Respectfully submitted,

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Certificate of Service 37 CFR §§ 42.6(e)(4)(i) and 42.105(b)

The undersigned certifies that on May 19, 2026, I will cause true and correct copies of the foregoing PETITION FOR INTER PARTES REVIEW OF U.S. PATENT NO. 10,539,851, and all associated exhibits or appendices referred to therein, to be served via FedEx Overnight to patent counsel of record at:

Mr. Weiguo Chen
SHEPPARD, MULLIN, RICHTER & HAMPTON LLP
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Costa Mesa, CA 92626

Respectfully submitted,

/James K. Cleland/
James K. Cleland (Reg. No. 44,619)
Dickinson Wright, PLLC

Certificate of Compliance Pursuant to 37 C.F.R. § 42.24

This paper complies with the type-volume limitation of 37 C.F.R. § 42.24.

This paper contains 13,614 words, which includes all annotated words in the Figures, but excludes the parts of the paper exempted by 37 C.F.R. § 42.24(a).

This paper also complies with the typeface requirements of 37 C.F.R. § 42.6(a)(ii) and the type style requirements of 37 C.F.R. § 42.6(a)(iii)&(iv).

Dated: May 18, 2026

Respectfully submitted,

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