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THE TRUSTEES OF PRINCETON UNIVERSITY
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Our Ref.: P 8317 O001 / KK

In response to the Grounds of Appeal submitted by the Opponents I to III, the followings submission is made on behalf of the Patentees:

I. Requests

The Main Request and First Auxiliary Request submitted with the Grounds of Appeal filed on 11 May 2012 are maintained.

If the Board of Appeal is of the opinion that the attacked patent cannot be maintained on the basis of the Main Request or the First Auxiliary Request, maintenance of the patent is requested on the basis of the herewith filed Second to Fifth Auxiliary Request claim sets, to be considered consecutively. The order of the Auxiliary Requests is indicated on each respective claim set.

KK:NH:MD:AO:sh

It is further requested to confirm the Opposition Division's decision not to admit documents S1 to S9 and D38 into the proceedings as they were late filed and are *prima facie* irrelevant.

Moreover, it is requested that the additional experimental data D42 to D44 and S10 not be admitted into the proceedings as they were only filed during the Appeal procedure and are also *prima facie* irrelevant. The Opponents had sufficient time to file the relevant documents during the first instance, within the legal opposition time limit.

II. Documents

In response to the Grounds of Appeal filed by the Opponents, the Patentees submit the following additional documents:

D45: Expert Declaration of Prof. Dr. Mark E. Thompson;

D46: Expert Declaration of Dr. Michael S. Weaver;

D47: Tang et al., Applied Physics Letters 1987, 51, 913-915;

D48: Organic Electroluminescent Materials and Devices, Eds.: Seizo Meyata and Hari Singh Nalwa, Gordon and Breach Publishers, Amsterdam 1997;

D49: So et al., International Journal of High Speed Electronics and Systems 1997, 8(2), 247-263;

D50: Shoustikov et al., IEEE Journal of Selected Topics in Quantum Electronics 1998, 4(1), 3-13; and

D51: Lee et al., Applied Physics Letters 2008, 93, 123306-123309.

Documents D47 to D51 correspond to References 1 to 5 cited in the Expert Declaration D45.

III. Article 100(c) EPC / Article 123(2) EPC

1. First Auxiliary Request

Regarding the Article 123(2) EPC compliance of the claims of the First Auxiliary Request, the Patentees kindly refer to the Grounds of Appeal (see chapter IV.).

2. Second Auxiliary Request

The Second Auxiliary Request claims are identical to the claims maintained by the Opposition Division and differ from the First Auxiliary Request in the deletion of the alternative feature *"a phosphorescent organometallic osmium compound"* and deletion of dependent claims 3, 6 and 7.

3. Third Auxiliary Request

The Third Auxiliary Request is identical to the Second Auxiliary Request with the exception that in claim 1 it is defined that the organometallic iridium compound is "*cyclometallated*". This amendment is supported by the description of the application documents as filed (see WO 00/70655, e.g., page 10, lines 18 to 20).

4. Fourth Auxiliary Request

The Fourth Auxiliary Request is identical to the Third Auxiliary Request, wherein in claim 1 the cyclometallated organometallic iridium compounds were limited to compounds *"with an aromatic ligand"*. This amendment is supported by the description of the application documents as filed (see WO 00/70655, e.g., page 14, lines 7 to 8).

5. Fifth Auxiliary Request

The Fifth Auxiliary Request is identical to the Third Auxiliary Request, wherein in claim 1 the OLED is further specified by the feature *"wherein the emissive layer is in contact with an exciton blocking layer"*. This amendment is supported by the description and the claims as filed (see WO 00/70655, original claim 28).

Therefore, the claims of all of the Auxiliary Requests fulfil the requirements of Article 123(2) EPC.

IV. Article 100(b) EPC / Article 83 EPC

1. Sufficiency of disclosure

In the Interlocutory Decision, the Opposition Division correctly concluded that the Main Request as well as all the Auxiliary Requests satisfy the criteria of Article 83 EPC.

All objections raised by the Opponents under Article 83 EPC focus on the allegation that the invention as defined in claim 1 is allegedly too broad to be carried out over the whole claimed range. This allegation, however, is not based on verifiable facts.

One way is sufficient

It is established case law of the Boards of Appeal that even one way of performing the claimed invention may be sufficient to support broad claims. For example, where the disclosure of a new technique constitutes the essence of the invention, the description of one way

of carrying it out enabling the skilled person to obtain the same effect of the invention by use of suitable variants of the component features is generally regarded as being sufficient under Article 83 EPC (see e.g. T 694/92, point 5 of Reasons). Furthermore, it is established case law that the objection for lack of sufficient disclosure presupposes that there are serious doubts, substantiated by verifiable facts (see e.g. T 694/92, point 5 of Reasons).

No verifiable facts to support serious doubts

Clearly, none of the Opponents has presented any verifiable facts which could support serious doubts that one of ordinary skill in the art is able to perform the invention over the whole claimed range.

On the contrary, the application as filed provides sufficient disclosure with respect to phosphorescent organometallic iridium and osmium compounds and their use as emissive dopants in OLEDs, enabling the skilled person to perform the invention over the whole claimed range.

For example, in the PCT publication pamphlet, basics of the claimed invention are explained in detail on pages 1, line 10, to page 5, line 20. Exemplary OLED structures and OLED materials such as host materials, electron or hole transporting layers are described on pages 6, line 7, to page 7, lines 22. An explanation regarding the suitable selection of blocking layers is given on page 7, line 23, to page 9, line 14. Exemplary organometallic iridium compounds are shown on page 14, line 11, to page 15, line 12. Examples of OLEDs and their preparation are given on page 11, line 1, to page 13, line 23.

Therefore, the patent is not limited to one example only. It provides ample data, examples and specific information as to structure, functions and effects.

Consideration of the skilled person's technical knowledge

It is to be noted that at the priority date of the patent a detailed knowledge on OLED technology already existed. Fluorescent emission from organic materials was already described in 1987 (see D47). Since then, this field of technology developed rapidly and only a mere ten years later, i.e. two years before the priority date of the present patent, OLEDs utilizing fluorescent emission were, for the first time, commercialized. Apart from the development of suitable fluorescent emitter compounds, considerable effort was invested in the art into the research and development of OLED materials such as electrodes, hole and electron transporting layers or host materials as well as in the improvement of OLED structures (see, e.g., D48, page 203 and 207 ff and D49, Fig.1). Since fluorescent OLEDs only differ from phosphorescent OLEDs in the type of emitter compound used, it is clear that the know-how regarding OLED materials and structures built up for fluorescent OLEDs is routinely transferred to phosphorescent OLEDs without any hesitation. Thus, on the priority date of the patent it was common technical knowledge in the art how OLEDs are fabricated and how to suitably select OLED materials such as electrodes, electron and hole transporting layers or host materials.

This is confirmed by item 4 of the Expert Declaration of Prof. Dr. Mark E. Thompson, one of the inventors of the present patent and an expert in OLED technology. The Expert Declaration of Prof. Thompson is attached herewith as

- document D45-.

The invention is an OLED, not an emitter compound

Regarding the allegation that claim 1 should recite structural features that are necessary in order to obtain a phosphorescent complex, the Opponents appear to opine, that the patent is directed to the provision of certain chemical species.

This is, however, incorrect. The contribution of the present invention to the prior art is the disclosure of a technical device, namely an OLED, which emits light by phosphorescence. The invention is not, *per se*, directed to the disclosure of compounds which are phosphorescent. Said device is defined in the claims by the type of emissive material used to produce the light emission of the device. The emissive compound incorporated into the OLED according to the present invention is defined by two main characteristics:

- Firstly, by its structural features, namely by the ligand types (organometallic), and the central metal atom (iridium or osmium), and,
- secondly, by its photophysical properties, namely its ability to provide phosphorescent emission.

The feature *"phosphorescent"* is an inherent material property which can be readily determined by a skilled person using routine measures, and thus, is a technical feature which clearly defines the compound that has to be chosen according to claim 1.

Therefore, complexes which do not fulfill the selection criterion *"phosphorescent"* do not fall under the claim. For example, the complex

discussed in D39 and D40 does not have the claimed property of being a phosphorescent compound under operational conditions of OLEDs. Consequently, the experimental data shown in D39 and D40 fail to put the sufficiency of the disclosure of the invention into question. This was also confirmed in the Opposition Division's Interlocutory Decision.

2. Technical contribution to the art of OLEDs

The teaching of the present patent, i.e. the provision of OLEDs comprising organometallic iridium compounds as emitters, constitutes a technical breakthrough which opened a new field of OLED technology for commercially relevant devices. Thus, a broad claim for the attacked patent is unambiguously justified based on the legal principle underlying the EPC, that the protection conferred by a patent should correspond to the technical contribution to the art made by the invention described therein (see e.g. T 694/92, point 5 of Reasons).

Nevertheless, the Patentees notice that the Opponents are still trying to create a contrary impression by defaming the contribution of the present invention. Allegedly, no technical effect could be attributed to the present invention and, further, allegedly the present invention only provides for an alternative compared to the OLED emitters of the prior art.

In direct response thereto, Dr. Michael S. Weaver, director of the Phosphorescent OLED Application Engineering and Development Department of the Universal Display Corporation, New Jersey, USA, provides further evidence which reduces the Opponents' assertions to absurdity. An Expert Declaration by Dr. Michael S. Weaver is filed herewith as

-document D46-.

Dr. Weaver points out that the finding of the class of organometallic Ir compounds as OLED emitters had an enormous impact on the phosphorescent OLED industry and that this class of OLED emitters paved the way for the commercial application of phosphorescent OLEDs. He concludes that after 19 years of research experience in particular in the field of phosphorescence OLEDs, he knows of no other class of phosphorescent compounds which could be regarded as an alternative to the organometallic iridium compounds claimed by the opposed patent.

Additionally, reference is made to the various explanations regarding the uniqueness of the claimed organometallic iridium OLED emitters, presented by the Patentees in previous submissions. In particular, the chemical and physical reasons explaining the advantageous of the OLEDs with the claimed emitters are apparent from the submission of 29 September 2011, during the opposition proceedings (see paragraphs II.3 to II.3.3). The aspects of the claimed OLED emitters regarding the extraordinary strong spin-orbit coupling, the very small energy gap between the excited singlet and triplet states, the alignment of the involved energy states and the resulting advantageous technical effects thereof for the use in OLEDs were thoroughly explained therein. Further, the corresponding recognition and praise of the present invention in the scientific world, for example the verification experiments done by OLED pioneer Prof. Tsutsui directly after the publication of the present invention, were also presented (see paragraph II.3.4 of the submission of 29 September 2011).

Therefore, it is clear, that the provision of OLEDs comprising organometallic iridium emitters is a technological breakthrough.

3. Breadth of the claim

In their Appeal Grounds all Opponents referred to Fig. 2 of the present patent and alleged that high external quantum efficiencies are only observed for the emitter $Ir(ppy)_3$ if specific OLED structures and materials are chosen. However, this represents a clear misinterpretation of the data shown in Fig. 2.

The core of the present invention is the finding that phosphorescent organometallic iridium complexes have the potential to outperform the efficiencies known from any prior art device when they are incorporated into an OLED.

It is self-evident and has ever been self-evident to a skilled person that the structure and materials of the OLED should be suitably selected in order to take full advantage of any emitter's potential to achieve high external quantum efficiencies. This, however, does not mean that the structure and materials of the OLED are essential features of the invention, which must be defined in the claim. Such features have been known at the priority date as is shown above (see IV, 1. "*Consideration of the skilled person's technical knowledge*"). In fact, demanding structure and materials of the OLED in claim 1 would be nonsensical from a technical viewpoint because for each emitter, the OLED structure is obviously optimized individually. Rather, the definition of the structure and materials of the OLED or emissive layer would necessarily represent an impossible or at least an undue restriction to the scope of the claim.

Using an analogy, the present situation is comparable to a situation, wherein an automobile with an improved and specific engine is invented and claimed. Certainly no one would seriously demand that the applicant should define the automobile in more detail regarding its structure (e.g. engine in front or back,

battery, or ignition system) and materials. It is obvious that a person skilled in the art of automobile mechanics will be able to suitably select the optimum automobile components in order to take full advantage of the power of the specific engine.

Figure 2 of the present patent only exemplifies such an optimization process of an OLED structure for a specific emitter, using $Ir(ppy)_3$ as an exemplary emitter. It is apparent from Fig. 2 that two different host materials were tested, namely Alq_3 and CBP. However, since the triplet energy of the host material Alq_3 is below that of $Ir(ppy)_3$, triplet excitons cannot be transferred effectively from the host to the dopant, but will mainly be deactivated non-radiatively. Consequently, CBP was chosen as host material for the emitter compound $Ir(ppy)_3$. Additionally, the inventors inserted a thin barrier layer of BCP to confine excitons within the luminescent zone and hence maintain high efficiencies (see patent, page 8, lines 5 to 7). In a further step the optimum doping level was determined by testing different doping concentrations, namely 1%, 6%, and 12% as well as a neat $Ir(ppy)_3$ layer. Page 8, lines 13 to 14 of the patent, state that the optimum doping level for the used OLED structure is between 6 and 8%.

The foregoing observations are in line with Prof. Thompson's Expert Declaration (see D45, item 5), who confirms that

> *"Fig. 2 shows exemplarily how a suitable OLED structure for a specific emitter, in this case $Ir(ppy)_3$, can be determined by doing a few routine experiments."* (see D45, page 6, last paragraph).

In view of the above, it is clear that Fig. 2 fails to prove what the Opponents allege, namely that the desired technical effect is unobtainable within the claimed range. Rather, Fig. 2 shows an optimization process of an OLED

structure for a specific emitter, as routinely performed by a skilled person at the priority date of the patent.

Thus, Fig. 2 in fact confirms that the compounds of the present invention can achieve a high degree of efficiency when used in OLEDs.

V. Article 100(a) EPC

1. Novelty

In the interlocutory decision, the Opposition Division correctly decided that documents S1 to S9 were late filed and not *prima facie* relevant and consequently did not admit them. The mere fact that these documents have been re-submitted in the Appeal fails to alter this and thus, the Patentees again expressly request that said documents should not be admitted into the proceedings.

Concerning Opponent I and II's latest arguments (see Grounds of Appeal of Opponent I, sections 2.4 and 2.5, and Grounds of Appeal of Opponent II, section 2.), solely as a precautionary measure, the Patentees would like to note the following with regard to the *prima facie* irrelevance of these documents:

- S7 fails to disclose all features of claim 1, and consequently, S7 is not novelty destroying,
- the Opponents' novelty attack is based on the combination of two documents, namely S7 and S9, which is inadmissible when assessing novelty, and

- even if S9 were to be considered in combination with S7, all features of claim 1 are still not disclosed.

The first compound disclosed on page 7 of S8 (English translation of S7), does not contain a direct metal-carbon bond, and thus, is not an organometallic compound in the meaning of the present patent.

As already explained in the Patentees' Grounds of Appeal, it is clear that organometallic compounds are defined as compounds containing direct metal-carbon bonds (see D4, page 1, first paragraph). This is also confirmed by the Prof. Herrmann's Expert Declaration, filed as document D40.

Furthermore, S8 does not disclose that this compound is phosphorescent. In this regard, Opponents I and II relied on the disclosure of S9. However, none of the compounds shown on page 7 of S8 are disclosed in S9. Rather, S9 discloses that tris(8-hydroxyquinoline)iridium is phosphorescent. This compound is, however, not identical to the first compound on page 7 of S8 because it lacks the SO_3^- group at the heterocyclic ring of the hydroxyquinoline ligand. Thus, there is no direct and unambiguous disclosure in S9 that the first compound shown on page 7 of S8 is phosphorescent.

In view of the above considerations, the subject-matter of independent claims 1 and 15 are clearly novel over S7.

2. Inventive step

The arguments presented by the Opponents are based on incorrect interpretations or out-of-context citations to parts of the documents, applying an inadmissible hindsight approach. It is clear, however, that the subject-

matter of the present patent involves an inventive step in view of the cited prior art.

In response to the inventive step arguments submitted by Opponents I to III with their Grounds of Appeal regarding the Second Auxiliary Request, the Patentees would like to make the following additional comments:

2.1. D1 in combination with any one of D7, D9, D10, D12, or D38

Regarding the Opponents' allegations with respect to the Second Auxiliary Request, on which the patent was maintained in the Opposition Proceedings, the following is to be noted:

Closest prior art:

It seems that all Opponents are of the opinion that D1 is the closest prior art for the subject-matter of the Second Auxiliary Request.

Difference over D1:

The subject-matter of claim 1 of the Second Auxiliary Request differs from D1 in that the emissive molecule is an iridium compound, and is organometallic.

Effect of difference:

The effect of the two distinguishing features is that the central iridium atom, in combination with the organometallic iridium-carbon bonding to the ligand, exhibits a strong spin-orbit coupling, as explained in paragraph 28 of the patent. In addition to the extraordinary strong spin-orbit coupling, the

organometallic iridium compounds have a very small energy gap between the excited singlet and triplet states due to their specific chemical structure (organometallic bond between central iridium atom and carbon atoms of the organic ligands). These unique properties promote *inter alia* intersystem crossing and efficient phosphorescence. As a result, the combination of both distinguishing features leads to a class of phosphorescent emitters having the following photophysical properties:

- a short phosphorescence lifetime,
- a very high phosphorescent quantum yield, and,
- the emission originates exclusively from the long-lived triplet state, which increases the theoretical efficiency limit up to 100%, as no fluorescence is observed.

Due to its extraordinary photophysical properties, this class of emitter compounds has the potential to function as a highly efficient emitter in OLEDs. This is clearly evidenced by Fig. 2 of the patent showing that by using a suitable OLED structure the external quantum efficiency of the device is boosted to values of up to 8%. That the class of phosphorescent organometallic iridium compounds can function as emitters with a high degree of efficiencies is also confirmed by Dr. Weaver's Expert Declaration (see D46).

Thus, the functional interaction between the distinguishing features achieves a combined technical effect which exceeds the sum of the technical effects of the individual features.

The objective technical problem:

As already explained above, due to its unique photophysical properties, the class of phosphorescent organometallic iridium compounds can achieve a high degree of efficiency in OLEDs.

Conversely, the non-organometallic osmium coordination complexes of D1 do not have this potential. Moreover, the OLED disclosed at the bottom of Fig. 1 of D1 already has a fairly optimized structure.

This is also confirmed in the Expert Declaration D45, wherein it is noted that the OLED of D1 comprises a heterostructure and a host-dopant structure, which improves the efficiency of carrier transport within the OLED. Furthermore, the host material PVK has higher triplet energy than the osmium complexes of D1, and thus is a good choice with respect to its energy levels. Nevertheless, the external quantum yield reported in D1 is below 0.1% (see D45, page 7, item 7). Therefore, the photophysical properties of the osmium coordination compounds disclosed in D1 are not ideal for applications in OLEDs.

In this context, it should be noted that this conclusion is confirmed by D44, the experimental data submitted by Opponent III, using the osmium complex E1 of D1 as emitter compound in OLEDs. Although the Opponent used a state of the art hole injection layer (Plexcore® OC AJ20-1000) and another host material (PVK/PBD), the observed external quantum efficiency did not exceed 0.4% (see D44, figure on top of page 4). Apparently, even with today's knowledge in OLED technology it was impossible to push the external quantum efficiency into a commercially applicable range.

In view of the above, it is clear that the present invention provides a technical effect and a technical contribution, greatly exceeding the disclosure of D1. This is also confirmed by Dr. Weaver's Expert Declaration (see D46, page 2, last paragraph). Consequently, the objective technical problem to be solved is the provision of a class of compounds which can function as phosphorescent emitters with a high degree of efficiency when used in OLEDs. In view of the foregoing, it is abundantly clear that the objective technical problem to be solved by the present patent is definitely not, as the Opponents allege, the provision of an alternative emitter.

The claimed solution:

The solution to the foregoing problem is provided in claim 1, namely, phosphorescent organometallic iridium compounds.

The claimed solution is not obvious:

The phosphorescent OLED reported in D1 has a very low electroluminescence (EL) efficiency of below 0.1% despite using a high photoluminescence (PL) efficiency emitter compound. However, on the priority date of the patent, fluorescent OLEDs having external quantum efficiency approaching 5% and a phosphorescent OLED having an external quantum efficiency of 4% were state of the art. Consequently, the skilled person is discouraged from combining D1 with any other document disclosing emissive molecules with high PL efficiencies.

Furthermore, as already explained in detail in the Patentees' submission of 29 September 2011, filed during the Opposition Proceedings, D1 contains no information that would prompt the skilled person to replace the Os(II) complex by another emissive material. On the one hand, D1 states that the

optimization of the cell structure should bring about higher intensity (see D1, page 247, right column, lines 23 to 24). However, on the other hand, in D1 it is noted that the ligand structure of the doped complex and its concentration may be adapted to obtain a higher EL efficiency (see D1, page 247, right column, line 24 ff.). However, none of the ligand modifications shown in D1 leads to an organometallic metal-carbon bond.

It is clear from the above observations that, based on the information given in D1, the skilled person would not have replaced the molecules listed in Fig. 1 of D1 by a molecule disclosed in any of D7, D9, D10, D12, or D38, with a reasonable expectation of success. Any such combination of references constructed by the Opponents is contrived, and results from an inadmissible *ex-post-facto* analysis, bearing in mind the present invention. There is no motivation in any of the cited documents for such a combination.

For completeness' sake, it should also be noted that none of documents D7, D9, D10, D12, or D38 are concerned with OLEDs, electroluminescence or emitters that are said to be suitable for OLEDs. Moreover, D7 and D9 even relate to a different technical field, namely oxygen sensors.

The Opponents' allegation that a skilled person would be motivated to look into papers concerned with oxygen sensors is simply wrong. In fact, this would be senseless from a technical viewpoint, since the technical requirements of OLEDs and oxygen sensors are contrary to one another:

Oxygen sensors are devices used for the detection of dissolved oxygen. These devices work by luminescence quenching in which the amount of light emitted by a phosphorescent material is reduced in the presence of oxygen by quenching. The quantity of light reduction is a direct measure of the oxygen concentration.

The main differences between oxygen sensors and OLEDs include:

- oxygen sensors use photoluminescence, OLEDs use electroluminescence,
- oxygen sensors utilize the "quenching" of light, OLEDs utilize emission of light,
- oxygen sensors rely on a gas-permeable liquid phase or a gas-permeable polymer in which the transition metal complex is suspended, OLEDs are sealed in order to exclude gases, particularly oxygen,
- oxygen sensors have no anode or cathode and can be non-conductive, OLEDs are based on electroluminescence and must thus be conductive.

Due to the different technologies, the requirements for the emissive materials are also different, in fact they are contrary. For example, while for OLEDs, emitters having a short lifetime are preferred, oxygen sensors benefit from emissive materials which have long-lived triplet states in order to detect the amount of the quenching effect precisely.

Therefore, a skilled person would certainly not consider documents about oxygen sensors when looking for new emitters which can achieve a high degree of efficiency when used in OLEDs.

As shown in detail above in the Patentees' Grounds of Appeal and their submissions filed during the Opposition Proceedings, there was no objective reason to combine the teachings of these documents with that of D1, other than hindsight knowledge of the solution as claimed by the patent. Consequently, the skilled person would not have combined any of these documents with D1.

With respect to all other objections raised by the Opponents, reference is made to the Patentees' Grounds of Appeal and the submission filed during the Opposition Proceedings.

2.2. Experimental data S10, D42 and D44 are "designed to fail"

All Opponents filed further experimental data which allegedly prove that the subject-matter of claim 1 of the Second Auxiliary Request, on which the patent was maintained in the Opposition Proceedings, failed to involve an inventive step over the whole claimed range.

However, documents S10, D42, and D44 are late filed and not *prima facie* relevant, and thus, the Patentees again request that said documents should not be admitted into the proceedings.

Moreover, as will be shown in the following, the experiments conducted by the Opponents are practically worthless since the skilled person's knowledge at the priority date and the most basic selection rules regarding OLED materials were ignored in these experiments. In other words, the experiments are again "designed to fail".

As already noted above in Section IV.1., on the priority date of the patent it was routine for a skilled person to select suitable host and layer materials for a given emissive molecule in order to produce a working OLED that utilizes fluorescent emission. Review articles and article collections that were available before the priority date of the patent already provided detailed information on the fabrication of such OLEDs and the selection of suitable OLED materials (see D48, page 203 and page 207 ff., or D49, Fig. 1). Since fluorescent and phosphorescent OLEDs generally have the same technical requirements regarding the energetic alignment of the different OLED layers,

the know-how acquired for fluorescent devices is transferred to phosphorescent OLEDs by the skilled person. Moreover, some phosphorescent OLEDs were also described in the literature before the priority date of the patent (see, e.g., D2).

The most basic requirement to ensure satisfactory function of an OLED is that charges, i.e. electrons and holes, can be carried through the OLED materials when a voltage is applied and that the generated excitons can be converted into a visible light emission (see D45, page 3, second paragraph). Furthermore, a proper matching of the energy levels of the OLED layers is a basic and self-evident requirement in order to effectively confine the carriers (see D48, pages 205 to 207). This merely reflects the basic physical principle that the lowest energy state of a system is preferred. With respect to host-dopant structures, wherein an emitter molecule is doped into a host material, it was general technical knowledge at the priority date of the patent that the host and dopant material should be properly matched with respect to the energies of their excited states so that the dopant provides a trap for the excitons formed in the host material (see D50, page 5, left column, and paragraph bridging pages 6 and 7). The foregoing is also confirmed by Prof. Thompson's Expert Declaration (see D45, item 4).

Summarising the above, at the priority date of the patent, the skilled person had a detailed knowledge on the fabrication of OLEDs and the suitable selection of OLED structures and materials.

It is clear that all this general technical knowledge in the art must be considered when conducting OLED experiments. However, the analysis of the experimental data S10, D42, and D44, submitted by the Opponents, revealed that always at least one fundamental requirement for producing a working OLED was disregarded when preparing all of the comparative

OLEDs described in S10, D42, and D44. Namely, the requirement of matching the energy levels of the OLEDs properly in order to effectively transfer and confine holes, electrons, and excitons was clearly disregarded by the Opponents.

Experimental data S10

In S10, an OLED structure was used, which is very similar to that disclosed in the patent, and thus, it is not surprising that similar external quantum efficiencies are obtained when using $Ir(ppy)_3$ as phosphorescent emitter in an OLED with and without a blocking layer.

However, in the comparative phosphorescent emitter Ir-2, one of the ligands of $Ir(ppy)_3$ was replaced by a chlorine and a triphenylphosphine ligand. Due to its electron-donating properties, the triphenylphosphine ligand will lower the HOMO level of the iridium complex below that of the host material. As a consequence, holes can no longer be efficiently trapped at the dopant (see D45, page 8, penultimate paragraph).

Experimental data D42

In D42, $Ir(ppy)_3$ was doped into the host material α-NPD or DNA, respectively, having a triplet energy below that of the dopant $Ir(ppy)_3$. Such a device structure means that energy transfer from the host to the dopant is energetically unfavorable, and thus, less likely to occur. Instead, the excited states are deactivated mostly non-radiatively (see D45, page 8, last paragraph and figure on top of page 9).

Experimental data D44

The triplet energy levels of the host materials PVK, PVK:PBD, α-NPD and α-NPD:PBD are favorable for the osmium complex E1, but are unsuitable for the iridium complexes E2 and E3. E2 and E3 are blue emitters having a wide band gap between their HOMO and LUMO levels, and a high triplet energy, while the osmium complex E1 is an orange emitter having a much smaller band gap and a lower triplet energy. Consequently, the excitation energy of the host material cannot be efficiently transferred to the blue emitting dopants E2 and E3 (see D45, page 9, last paragraph and figure on top of page 10).

It is proven by the scientific paper D51 that a skilled person's correct selection of the host material for the emitter E2, can boost the external quantum efficiency of an OLED up to 10%! (see D51, page 93, right column, last paragraph). Thus, D51 clearly disproves the experiments of D44 and confirms that the class of organometallic iridium compounds has the potential to function as emitters with a high degree of efficiency when used in OLEDs.

From the above analysis of the experimental data S10, D42, and D44 it is apparent that in all cases the triplet energies of host and dopant materials were improperly selected in that incompatible material combinations were chosen. Therefore, it is the Patentees' impression that either the experiments were not conducted by a person skilled in the art or, were "designed to fail".

S10, D42, and D44 are scientifically completely meritless, and thus, are incapable of casting doubt on the present invention.

VI. Conclusion

Considering the arguments and relevant background information provided above, in the Patentees' Grounds of Appeal and the Patentees' submissions filed during the Opposition Proceedings, the request to maintain the patent on the basis of the Main Request or any one of the Auxiliary Requests and to reject the Appeal of the Opponents is fully justified.

Maiwald Patentanwalts GmbH
(Norbert Hansen)

Encl.:
Second to Fifth Auxiliary Request
Documents D45 to D51