Edited by
Harald Apelt

Do divers really need underwater lamps?

It is a simple question to which there is no simple answer, as it all depends... If you are mostly diving in Southeast Asia or the Caribbean where visibility is fantastic, during days of bright sunshine and in waters of 20m or less, you probably don't need one. But if you plan on diving in lakes, doing night dives, penetrating wrecks or do any sort of technical dive, then a good lamp becomes an essential part of your diving gear.

How to choose

Lamps

By Harald Apelt

PETER SYMES

WOLFGANG PÖLZER

What do you need? Which lamp type is best for you? It all depends, as the article explains...

What makes an underwater lamp a good lamp?

First of all, it needs to be bright and closely reproduce the colour of daylight, so it shows the colours as realistic as possible. For a long burn time, it needs to be equipped with a high capacity accumulator. A short charging time is also essential, especially of you plan on having several dives in a row.

Size and weight is also of importance because of weight limitations and space restrictions when it comes to bringing it on an aircraft. It is not really a question of build quality, but rather of comfort, in how the lamp can be transported in an aircraft. Due to airline regulations the bulb or lamphead has to be transported separately from the accumulator, so divers are normally required to detach the bulb.

There is a wide variety of different lamps and techniques available. First of all, you will have to determine which sort of diver you are. As mentioned before, the requirements for a lamp are different, and that's why you should decide which type of diving you are going to use it for. Do you need a system of extreme durability and power for extended cavern dives, or just a small lamp for your BCD pocket?

Do you require a 10 Watt backup-light or a 100 Watt high performance spot? And which system will meet your requirements best? Is it a halogen-lamp, a Xenon-light, the "power pack" HID (High Intensity Discharge) or the LED-technique (Light Emitting Diodes)?

This tiny HID from Singaporian Aunoc is less than three inches long and will fit into any pocket, yet it boasts an impresssive output

Underwater lamps can be classified into three basic categories:

There are handlamps with batteries, rechargable handlamps with accumulators or *acculamps,* and lamps with external battery packs or *accu-tanklamps.* The operation of these three types are quite different.

Those divers who need a lot of light for a long time, will become fans of an accu-tanklamp. The canister with the accumulator is normally fixed on the side of the tank

The XHL-4500 rechargable handlamp from Metalsub represents the mid-sized solution

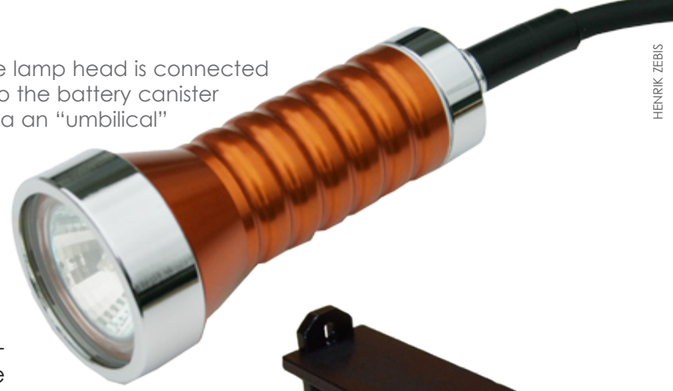
The battery pack can be attached to your tank with a clamp

and is connected with a cable (*umbilical*) to a lamp head which is held in the hand. The lamp head quite often has a special grip—a so-called Goodman-grip— which makes the use of the lamp head very comfortable. For cavern dives, there is also a special version that fixes the lamp heads to the helmet. These accu-tank lamp are often the choice of tech- and wreck divers. Videographers also tend to prefer the tank-system because of its high capacity.

The disadvantage of these lamps is their high price and their high weight. These are the main reasons why they are not widely used by classic sport divers.

The powerful and high quality alternatives to these complex systems are the accu-handlamps. They are normally made of aluminium tubes, have an integrated accumulator-pack of different power, and they are available with all kinds of above mentioned bulbs.

The cheaper alternative to this kind of lamps are the battery lamps. They are mostly made of plastic and can be used with rechargeable or normal batteries. These batteries—whatever is used—can be easily removed and makes this type of lamp very comfortable for



The lamp head is connected to the battery canister via an "umbilical"

HENRIK ZEBIS

With a "Goodman-grip", you can carry the lamphead on the back of your hand

SCUBALIGHT

The high-end lamp type. HID Lamps like the H10 from American Diverite with eight hours of burn time are the choice of many technical divers

DIVERITE

flight transportation. The lower price of the battery-lamps seems to be a good argument for scuba divers as well.

The biggest disadvantage of these two more professional types of lamps lies with the accumulator. They have to be handled with care. One highly important aspect is quite often neglected by the owners: Reading the instruction manual. Here you'll find the important answers to which kind of accumulator is used in your lamp, how and in which intervals it must be loaded, and how to prevent the damages of memory effect or wrong long-term storage.

New technology

The newest technological development is a mixture of all three types of lamps. These modular systems are designed by several companies (for example Green Force or TillyTec Lightsystem) with a lot of creativity and imagination.

The lamp is divided in different segments, which is the reason why it is possible to interchange the different lamp heads with different accumulator-packages, too. It is a big advantage because now you can start with a "small" solution and "upgrade" later to a more powerful system.

In the end, you are able to reduce or upgrade the battery-pack of your light-system, use two different lamp heads and set up the exact light-system you need for your next dive.

The limits to what you would like to invest in the best hobby in the world is really only set by the size of your budget.

HARALD APELT

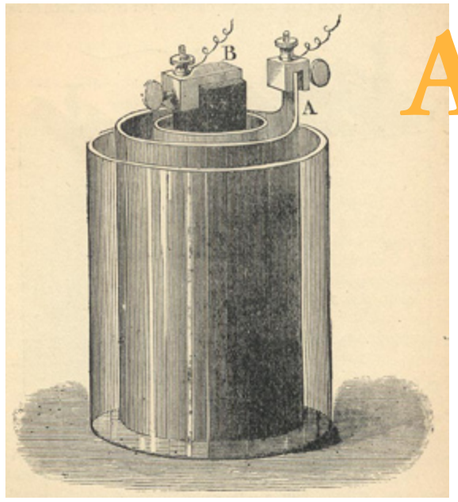
Durable, cheap and with good perfomance. Lamps like this battery LED lamp (left) and 10 W with rechargable NiCad batteries have become commonplace

The LED lamp has a burn time of more than six hours on just three standard batteries. The lamphead is rated at +50,000 hours lifetime

Scubapro's bid for a modular lamp system. The lamp heads are available in halogen, HID and LED

URS ANLIKER

Big battery packs can be mounted on the tank or on the harness



Batteries & Accumulators

If the bulb is the heart of an underwater lamp, the accumulator is its soul

Cadmium, which is used in rechargable batteries, is also an environmental hazard

If the bulb is the heart of an underwater lamp, the accumulator is its soul. And as with humans, the soul can be difficult to comprehend. There are a lot of different types of accumulators available for underwater lamps, but at present, none of them is absolutely perfect. All of them generate electricity through some chemical process inside, and all of them have certain characteristics that affect them from being a perfect energy storage.

Good price

The most widely used accumulators in diving lamps presently are nickel-cadmium-accumulators (NiCad). They have been used worldwide for many years, and because of mass production, are reasonably priced.

But there are a few disadvantages with this technology. As Cadmium is environmentally problematic the European Parliament has passed a ban using NiCad-accumulators in diving lamps in the European Union—and, as usual, at the same time they granted an exemption for the continued use of NiCad-accumulators in power tools. The ban is going to take effect from October 2008.

Downsides

The technical disadvantages of NiCad-accumulators include the need for new lamps to undergo up to ten cycles of charging and discharging before they reach their full capacity. Another problem is caused by the self-discharge effect, which is responsible for suboptimal shelf life. But the most noted disadvantage of NiCad-accumulators is the memory effect, which is due to mistakes and bad handling by the user when recharging the accumulator. Last but not least, at the end of its usable life, a NiCad-accumulator has to be disposed of as hazardous waste (and so do the other types of batteries).

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Extermal charging is more practical

The next generation of accumulators were the nickel-metal-hydride accumulators (NiMh). They have a good rate of possible recharging cycles: 500 up to 1000 charge cycles can be reached with these accumulators. Unfortunately, these accumulators tend to become weak once they get overcharged. They also tend to discharge during storage and react with a loss of capacity at low temperatures around zero degrees Celsius.

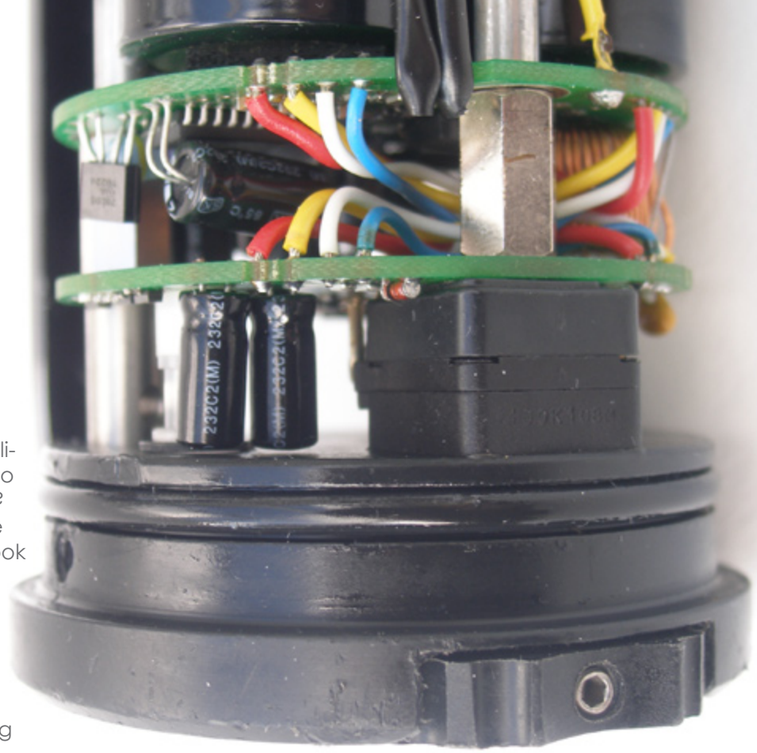
The options

So what is the best solution for our diving lamps? For quite a while, the general consensus seemed to be that the lithium-ion accumulators, which have proven their value in mobile phones and laptop computers, would also be the perfect solution for diving lamps. They are small, light weight and have a short charging time. They can be charged without opening their container, at any time, and in any state of charge. And they also work fairly well in the low temperatures below freezing. In addition, no self-discharge and no memory-effect is known in this technology. So, it seemed like a perfect solution until some cases of notebooks and cell phones caught fire, resulting in the closer scrutiny of this technology. Lithium-ion accumulators are indeed tricky to handle and can become dangerous, as they might react to physical damages with explosions and burnouts. The worst issue is that once they catch fire, they are nearly impossible to extinguish.

The charging technology for these accumulators is a complicated matter, especially when HID bulbs are used. Then, the operation of a lithium-ion accumulator becomes a very complex process. That's why most of the manufacturers of lithium-ion accumulators are not issuing any warrants for the usage of these accumulators in diving lamps. Except Sanyo. This company is delivering their accumulators only to lamp producers, who ran a special test and have integrated a special PCB-electronic device that powers down the accumulator in case of technical problems. Manufacturers like German Kowalski is using the Sanyo accumulators for the lithium-ion HID-lamp "maxum", and they are in good company as some aircraft manufacturers have chosen to use the same cells in their airliners. This and the certification by the Federal Aviation Administration (FAA) ensures that the technology is considered safe and can be used without problems, provided that the safety and processing issues are being handled correctly.

Nearly the same technology is used in the lithium-manganese accumulators. They keep their efficiency in cold water and a good shelf life. Another advantage is that they don't need safety electronics and may be charged in closed containers, too. They are said to be safer, but they are not as powerful as the lithiom-ion versions, and long-time storage without use might reduce lifetime of these accumulators.

Which type of accumulator is best for you depends on your intended usage—as well as the size of your wallet.



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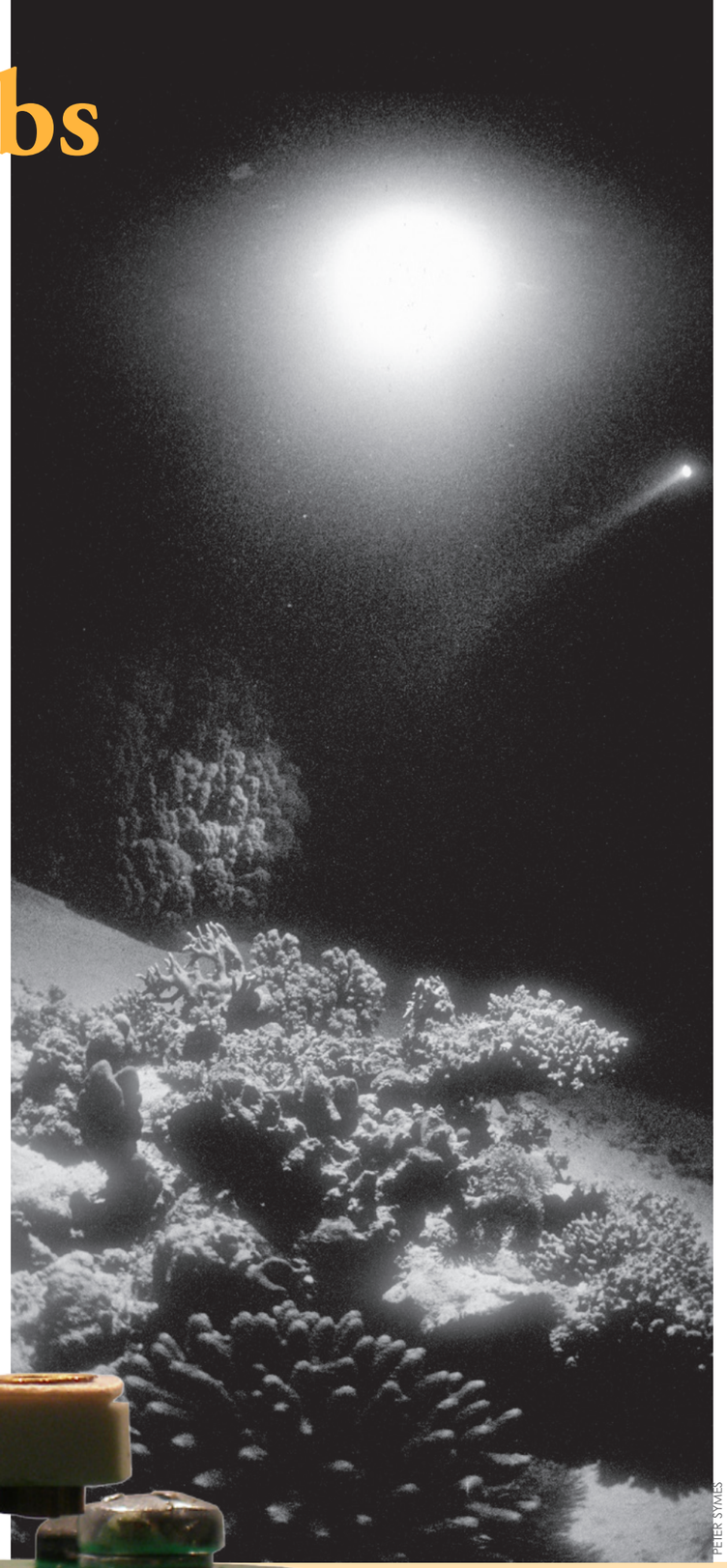
Charging your lamp

Do you have to open it to charge it, exposing the delicate innards to the elements? You also have an o-ring to look out for and make sure it is watertight every time you close the lamp after each charging session

Bulbs

U.S. Patent 0,223,898 by Thomas Edison for an improved electric lamp, January 27, 1880

Just imagine. You are out on a night dive somewhere nice with a group. You switch on your new 50 or 75W dive lamp flood-lighting the whole reef for everyone to see, instantly making you the person of the day.



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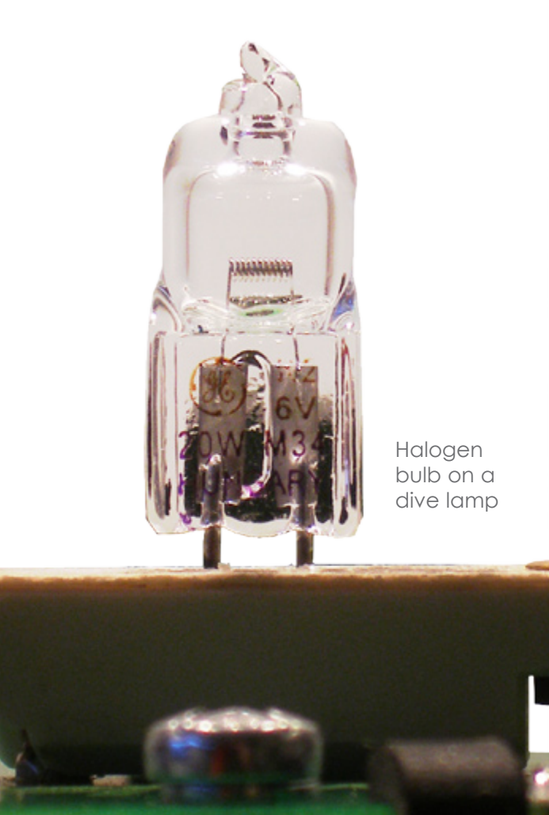


Halogen bulb on a dive lamp

Thanks to a little help from technology and the latest developments in light bulb manufacturing, we now have an impressive output at our fingertips. It has only been a few years since the LED-technology (Light Emitting Diodes) was the laughing stock, but now it's on the cutting edge. State-of-the-art used to mean Halogen bulbs. Later, Xenon bulbs became the buzz word, and then—as seen in cars—HID-bulbs (High-Intensity-Discharge) were all the rage.

Let's take a closer look at the differences.

Halogen

The halogen lamp is similar to the conventional non-halogen incandescent lamp in that it employs a tungsten filament in a gas-filled, light-transmitting glass-shell and produces the same type of light. It has a colour temperature of about 3600 Kelvin, which means it emits a slightly red and "warm" light. (See next page for explanation of "Colour temperature").

The major difference is that a halogen vapour (Iodine or Bromine) is added to the inert gas inside the glass bulb, and the gas pressure and bulb temperature are much higher than in non-halogen lamps. Also, the bulb is made of fused quartz, high-silica glass or aluminosilicate "hard" glass, which is capable of withstanding the high operating pressures and temperatures.

Tungsten

Tungsten-halogen lamps operate in a "halogen regenerative cycle", which maintains constant light output and colour temperature of about 3600 Kelvin throughout the life of the lamp. The halogen cycle permits the use of more compact bulbs than those of conventional tungsten-filament lamps of equal ratings, and also permits either increasing lamp life to approximately twice that of conventional tungsten filament lamps having comparable wattage and colour temperature.

Xenon

The halogens were succeeded by the Xenon-lamps. These are similar to halogen-lamps, only filled with Xenon gas instead. This makes the filament burn at a higher temperature, resulting in an increase in output of about 50 percent. That's why Xenon bulbs seem to be brighter and whiter than halogen bulbs. They, too, can be used with over voltage that increases the light efficiency as well. The downside is that the higher working temperature, and the over voltage reduces lifetime of the bulb. The nominal lifetime of a Xenon bulb is only around 100 hours. Halogen-bulbs will last up to ten times as long.

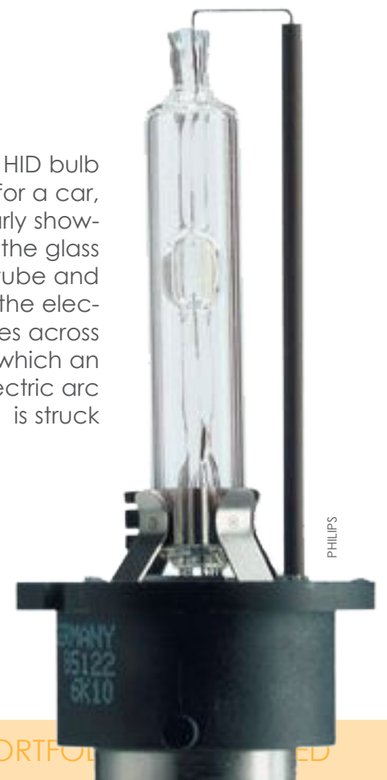
HID

HID-technology was first widely used in cars. HID stands for *high-intensity discharge*, which is the technical term for the process which produces the light by striking an electrical arc across tungsten electrodes housed inside a specially designed inner fused quartz tube. This tube is filled with both a gas and metals. The gas aids in starting the lamp. When a HID-lamp is switched on, an ignition spark of about 25,000 Volt ionizes the gas, which is under high pressure. The metals produce the light once they are heated to the point of evaporation, forming plasma.

Note that a HID bulbs are, in fact, also filled with Xenon gas which may lead to some confusion.

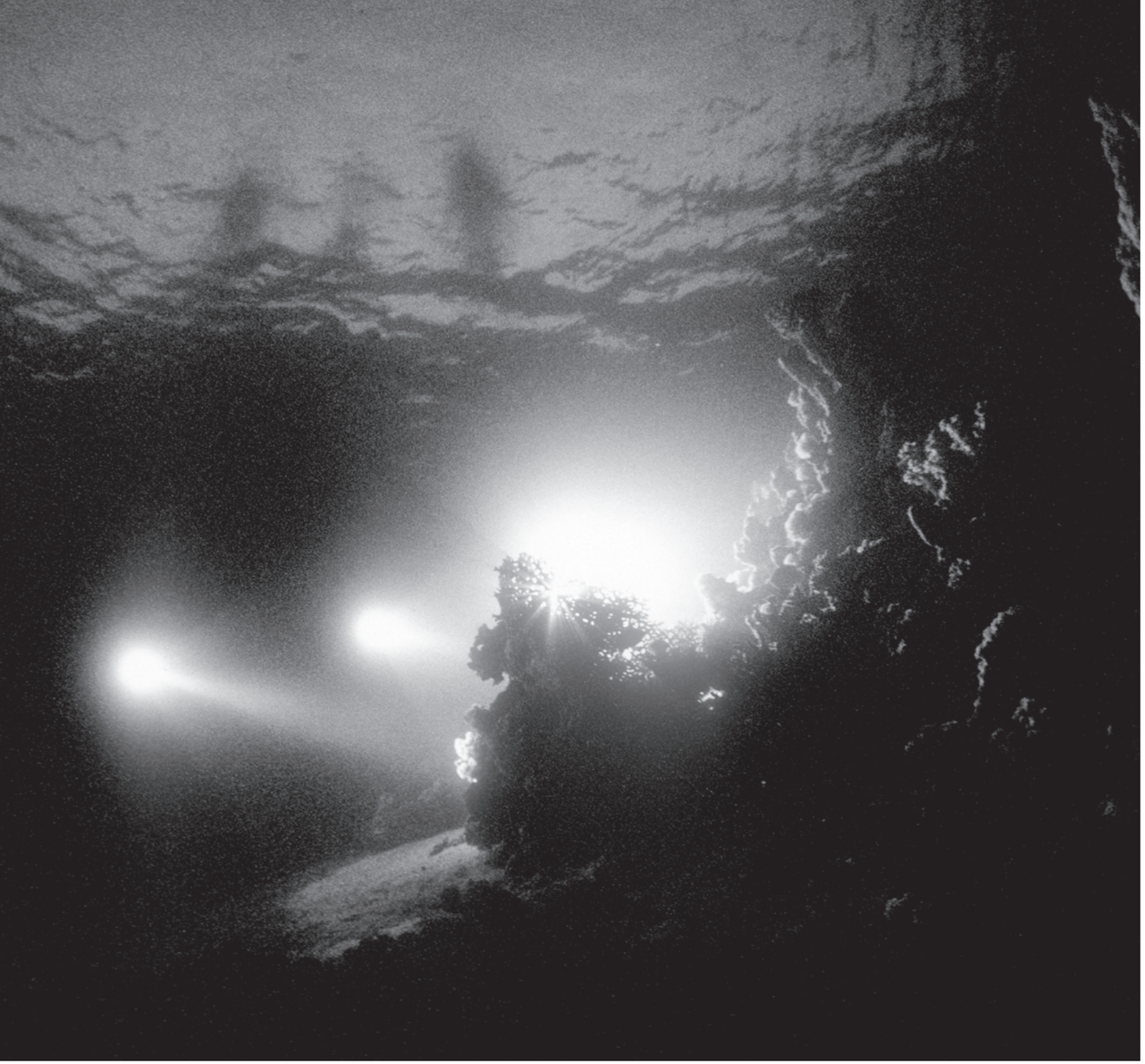
The Xenon bulb in Kowalski's XR mini-X produces a light with a white to bluish tint

KOWALSKI



PHILIPS

A HID bulb for a car, clearly showing the glass tube and the electrodes across which an electric arc is struck



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After ignition a rather complex piece of electronic circuitry adjusts the voltage from the high ignition levels down to a process-voltage of about 60 to 90 volt. Once running, the arc produces a better and brighter light than the lamps with filaments while using less energy.

By comparison HID bulbs produce between 2,800 and 3,500 lumens using between 35 and 38 watts of electrical power, while the performance of halogen filament bulbs lies between 700 and 2,100 lumens while consuming between 40 and 72 watts at 12.8 Volt.

The light from HID lamps has a distinct bluish tint when compared with tungsten-filament headlamps. The bluish tint is less absorbed by water so the HID-beam has a better penetration than a comparable halogen beam.

HIDs are well suited for cave and wreck diving. But not optimal for the casual diving on reefs in daylight in depths of no more than 10-15m. As the red parts of the light spectrum are being absorbed first by the water with the blue colours being filtered last, what you mostly need at these shallower depths is boosting the red tones.

Xenon HID

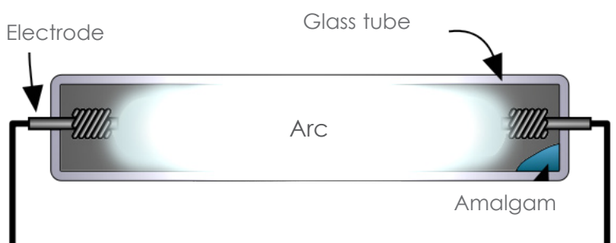

Diagram over a HID bulb

Another advantage of HID-lamps over halogens is their much longer lifetime of about 5000 hours. In addition, the colour temperature of HID lamps of 5500 to 6000 Kelvin closely resembles that of daylight (5700K) making it near ideal for photo- and videography. This is also why these lamps have gained such popularity with indoor gardening and made it practical, especially for plants that require a lot of light, like vegetables and flowers. They are also used to reproduce the intense tropical sunlight for indoor aquariums.

Consequently you are not looking for the neutral or even bluish colours of HID lamps for normal scuba dives at daytime.

By contrast the higher colour temperature of HID-lights photo and video purposes makes them the choice of photo- and videographers. Especially when it comes to illuminating the shady parts of the reef on day dives and to the illumination of wrecks and caverns the advantages of HID-technology really shows.

Scanning Electron micrograph of a light bulb filament (75x(

The Halogen bulb emits a reddish light

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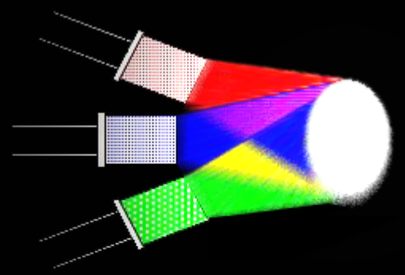
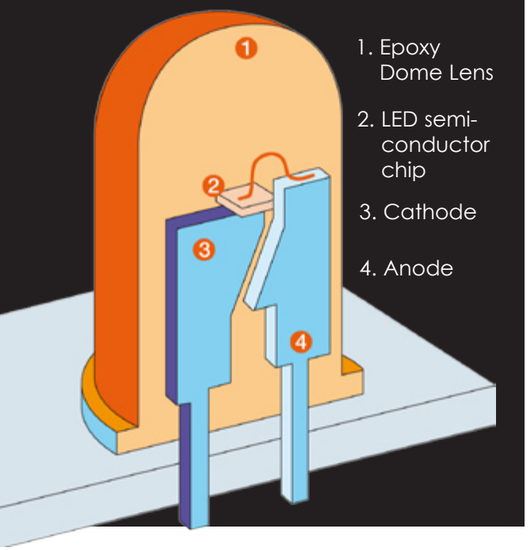
Why it is called colour *temperature?*

As we know from the glow of i.e melting iron it changes colour according to how hot it is. This phenomenon is used to link colour with temperature. The colour temperature of the thermal radiation from an ideal black-body radiator (a hypothetical material that reflects or emits no other light) is defined as equal to its surface temperature in Kelvin degrees. 5500 K is widely considered "standard daylight"



Making white light with the LEDs



LEDs as most of us know them.
Omnipresent, innocous, not sexy at all

mb sub is the first
to introduce a diving lamp
based on the new Osram Ostar LED

Thanks to a new production technology this substrate can be removed and the surface of the light generating layer coated with a thin metal film. This metallised side now serves as a reflector and is placed close to the top of the LED. The result is that the LED can emit almost all of its light at the top, which causes a major increase in brightness.

What is: Lumen?

The lumen (symbol: lm) is the SI unit of ***luminous flux***, a measure of the perceived power of light. Luminous flux differs from *radiant flux*, the measure of the total power of light emitted, in that luminous flux is adjusted to reflect the varying sensitivity of the human eye to different wavelengths of light.

A standard 100 watt incandescent light bulb emits approximately 1700 lumens in North America and around 1300 lumens in 220 V areas of the world.

Definition
$1\ lm = 1\ cd \cdot sr = 1\ lx \cdot m^2$

SOURCE: WIKIPEDIA

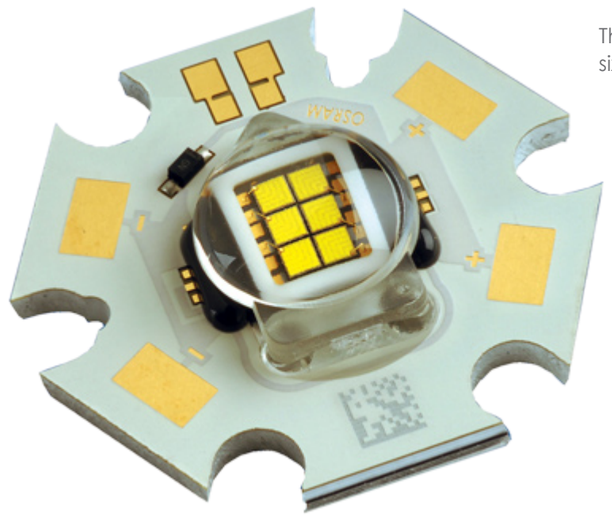
'Laughable' LEDs

For many years LED's were simply thought of as small and dim lights in electronic devices and signal lamps. How times have changed. There are quite a lot of technicians and scientists who now believe that the LEDs will be the lights of the future.

LEDs are characterised by a low energy consumption, extremely long life span, compact dimensions, and they are shock and vibration resistant. Another advantage of this innovative illuminant is that it has a very low failure rate and emits no ultra-violet or infrared radiation. In recent years, there have been significant developments with substantial improvements in this technology. Recently, a major breakthrough took place with the development of the Osram *Ostar* light emitting diode.

The technical innovation lies in a perfect interplay between various manufacturing techniques. LEDs consist of semiconductor crystals that grow on a substrate during manufacture. Up to now, the substrate remained in the diode after manufacture, where it absorbed much of the light produced.

The Ostar high brightness LEDs are built with a multichip-onboard-technology with four- and six-chip-versions. The LED is the first LED to exceed 1000 lumen in output—and that is just with the 15 Watt version. That means that diving lamps equipped with this chip will produce the brightness corresponding to that of a 50 Watt halogen lamp. The first prototype is already built, and the output is perfect. German lamp constructor Michael Bienhaus from mb sub is the first to introduce a diving lamp based on the new Osram Ostar LED. He has already marketed an underwater hand lamp, the "Photon". It comes



The Osram Ostar LED chip packs
six LED in an array

with a two stage dimming and 12.6 Volt 1.6 Ah LiMn (lithium-manganese) accumulator. This power package has a burning time of about 60 minutes followed by an additional 30 minutes of emergency lighting. All this just weighing in at a little more than half a kilogram of weight—a big step towards optimizing dive gear. As the LED module costs about 37 Euro, the complete hand lamp will be sold for 472 Euro.

Pushing the envelope

Sources have also informed us that a group of German lamp nerds have already constructed a 20 Ah tank lamp with this technology. Into the small lamp head they integrated four of the new Ostar LEDs. Due to the extreme process temperatures, this lamp can only be used in water.

But with a burning time of about five hours and a whopping output of 3200 lumen—which is about 200 percent more than a strong HID burner makes—it is now possible to illuminate an entire reef at night and in bright colours. (For more information's about this lamp project see www.tauchfunzel.de—unfortunately, only available in German).

The next revolution of underwater lamp-technology has just begun in earnest. And at least in this regard, the future looks bright indeed. ■

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Reliable lamp systems are essential when it comes to the more demanding types of dives. Don't skimp on quality

The 'Revolution' from mb sub is equipped with three 3 Watt LEDs (left). There are three interchangable heads available in the system. The two others are halogen and HID

LEDs are characterised by a low energy consumption, extremely long life span, compact dimensions and they are shock and vibration resistant.

How to shop for an underwater lamp

10 tips for beginners

1. First consider which kind of dives you want the lamp for. Then find the type of lamp that will match the requirements.

2. Next, try and get an overview of which lamps are on offer in this segment and select some "candidates" to your liking. Don't put emphasis on look and aesthetic design, but on the technical details.

3. Purchase a lamp with a high quality accumulator from a shop with good reputation. Why? Because accumulators have a limited life span, and you want to make sure that your new lamp hasn't already been spending a good part of it sitting on a shelf in the back of a shop.

4. Your charging device should have an integrated quick charge circuit and a total discharge protection to make sure that use of the lamp and the charging will be done with consideration.

5. Lamps with exterior charging should be preferred. You shouldn't need to open a lamp to charge it with the risk of subsequent leaks or damage to the delicate parts while open.

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6. The lamp should be dimmable or have two or rather three different power levels.

7. For the sake of safety reasons, the lamp should have an integrated automatic SOS signal generator

8. Ask your dealer for technical data on the lamp such as burning time, recharging time and light performance presented in a data sheet or a manufacturer brochure.

9. If your budget allows a more convenient solution, you should prefer a modular system where you can upgrade your accumulator or use different lamp heads.

10. Decide upon the weight of your lamp. Each kilogram counts when checking luggage in at airports, and the weight limits will only become more of an issue in the future. Also, as airline regulations already require that accumulator and bulb must be transported separately, it is an advantage having a modular lamp system. ■

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"Boys with toys"

Divers with good lamps have more fun