Near-UV light detection

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Near-UV light induced fluorescence has already proven to be very useful as an alternative to classic caries-detector dyes. However its potential for detection purposes and as a support to the final diagnosis goes far beyond that single indication: from evaluation of micro-leakage, plaque detection, fissure cleaning control, detection of fluorescent restorative composites and resin cements, up to crack transillumination. Thereby, a near-UV light emitting unit offers a wide set of features that can be extremely useful in our daily practice; however most of the existing products available are either dedicated devices with low intensity, or light curing units with filters that ultimately also provide a very low intensity of near-UV light.

The new GC D-Light Pro is a wide-spectrum LED light-curing unit that offers as part of its programs a medium intensity (390mW/cm2), 405nm light Detection Mode, opening a new world of fluorescence-based clinical information while keeping an extremely high versatility as a light-curing unit.

The visible spectrum of light in human vision ranges approximately from a deep violet at 390nm up to dark red at 750nm (Figure 1). The spectrum under 390nm - called ultra-violet light, UV - is invisible to the human eye but is able to produce a phenomenon called UV-induced fluorescence: the absorption of invisible UV light by a material and subsequent emission of visible light. UV-induced fluorescence is very well-known and documented in dentistry as it is naturally taking place in dental hard tissues (especially dentin), producing a mild blue light emission (Figure 2). However there is another, less known, form of fluorescence that also takes place in dental tissues: the near-UV-induced fluorescence. In this case it is a visible violet light close to the ultra-violet region (usually around 405-410nm) which will induce a weak green fluorescence light emission from

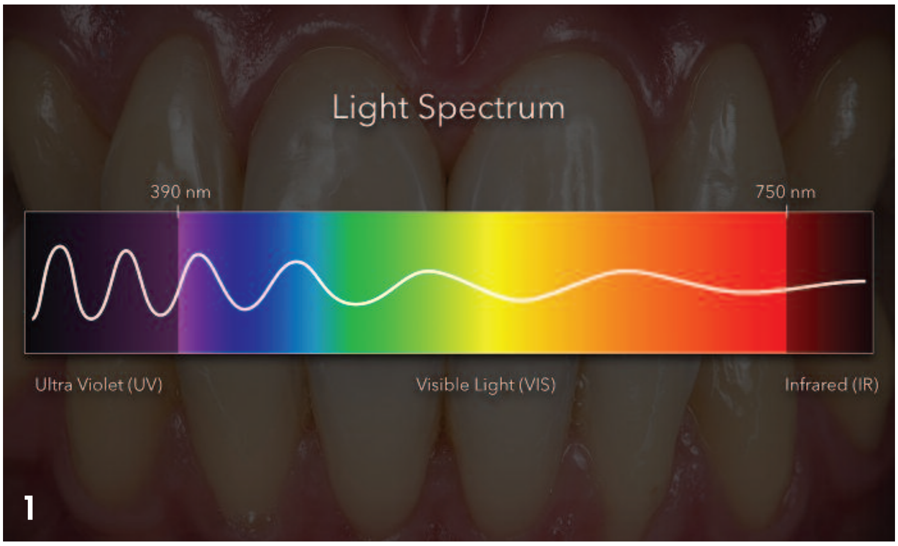

Figure 1: Visible light spectrum chart

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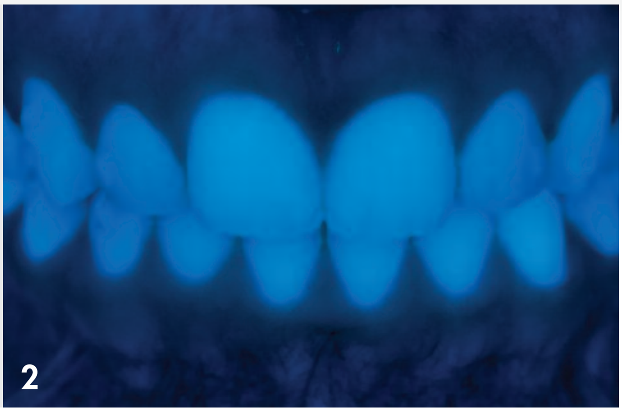


Figure 2: UV-induced fluorescence of natural teeth (fluor_eyes® by emulation)

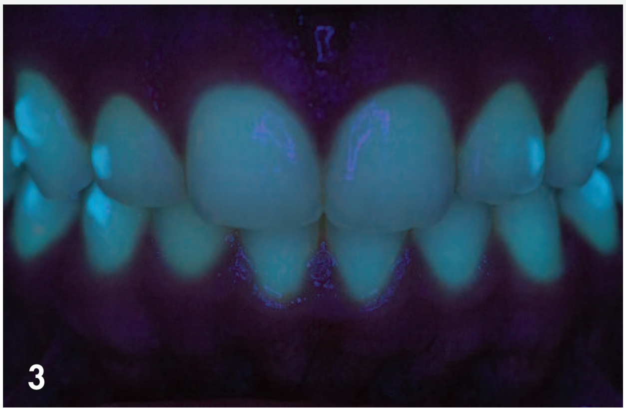
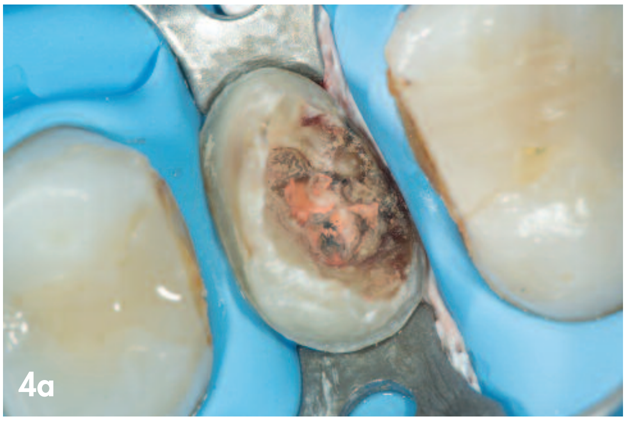


Figure 3: Near-UV induced fluorescence of natural teeth (Digi-Slave L-Ring 3200UV by SR Inc.)



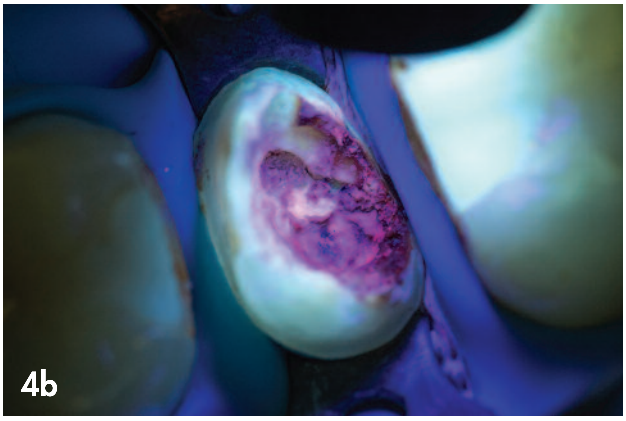


Figure 4a and b: Caries detection during caries removal therapy (with & without D-Light Pro)

dental tissues (Figure 3). Furthermore, this near-UV light is able to induce a red fluorescence emission in bacterial porphyrins and a strong blue fluorescence emission in most modern dental composite resins. These two additional fluorescence phenomena together with the contrast generated with the fluorescence of natural teeth enable the application of near-UV light units for many different clinical purposes outlined below.

Caries detection during caries removal therapy

The so-called fluorescence-aided caries excavation technique (F.A.C.E) based on near-UV light was introduced to take advantage of the green fluorescence emission of teeth against the red fluorescence emission of bacterial porphyrins (Figures 4a & 4b). This high contrast of color (green VS red with filter, or blue VS pink without) provides a very useful alternative to classic detector dyes, enabling a precise caries removal in a cleaner way without over-staining of organic components like the dentinoenamel junction or false positives closer to the pulp chamber.

Plaque indicator

The high intensity of the red fluorescence produced by bacterial activity (bacterial porphyrins) makes it possible to control the presence and complete removal of plaque during prophylaxis as well as periodontal treatments (Figures 5a & 5b). Moreover the meticulous evaluation of prosthetic margins with this light provides a valuable tool to check local plaque retention as well as possible leakage / dissolution of cement (Figures 6a & 6b). This becomes even more critical

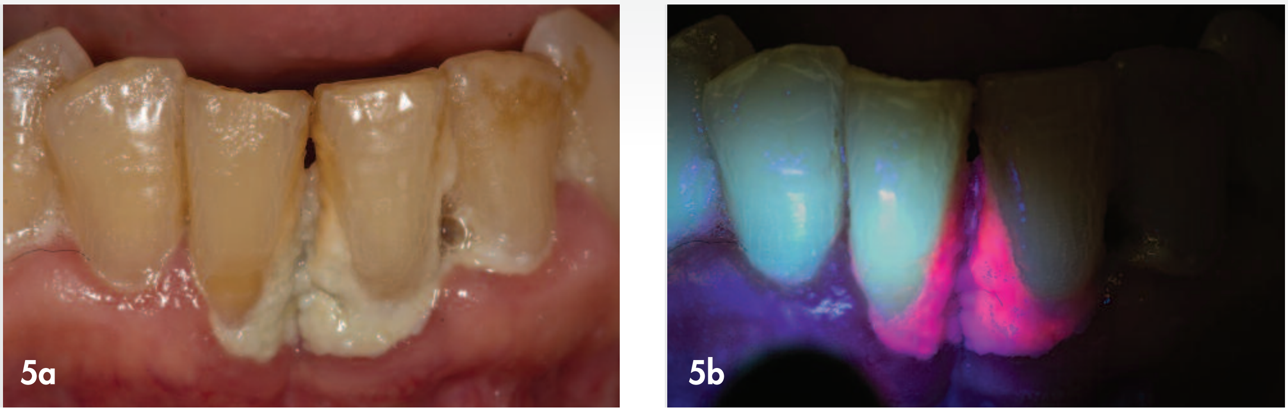


Figure 5a and b: Plaque detection (with & without D-Light Pro)

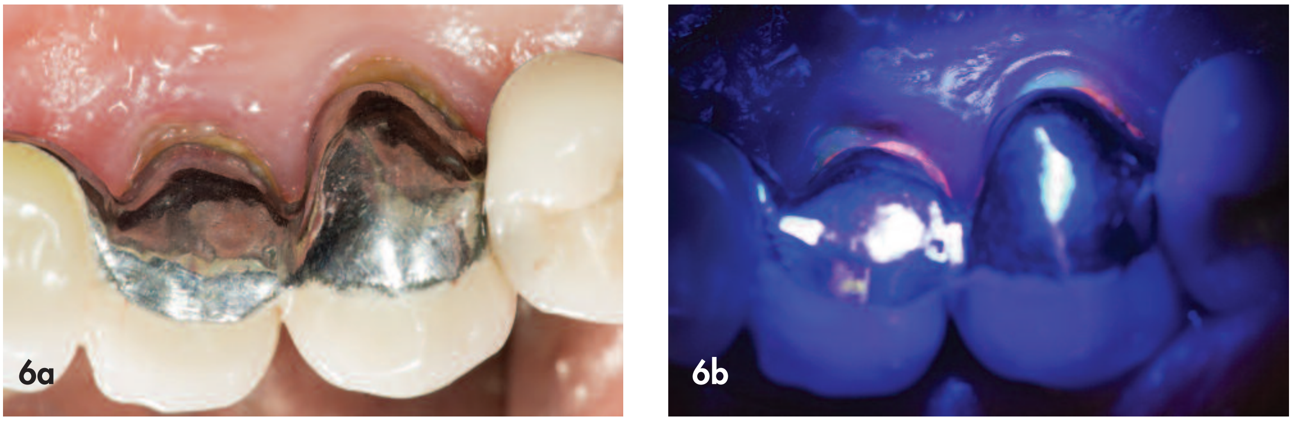


Figure 6a and b: Plaque detection in prosthetic margins (with & without D-Light Pro)

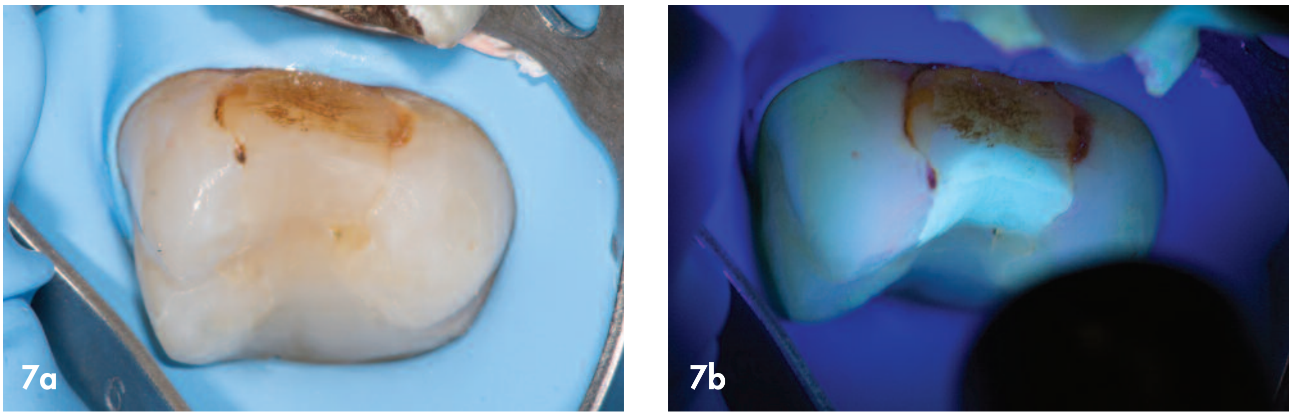


Figure 7a and b: Micro-leakage evaluation (with & without D-Light Pro)

in the case of classic metal-based prostheses where plaque evaluation might be very difficult due to obscuration of light transmission by the metal framework.

Micro-leakage evaluation

Marginal discolorations in restorations are very often observed in a daily practice. However, discriminating

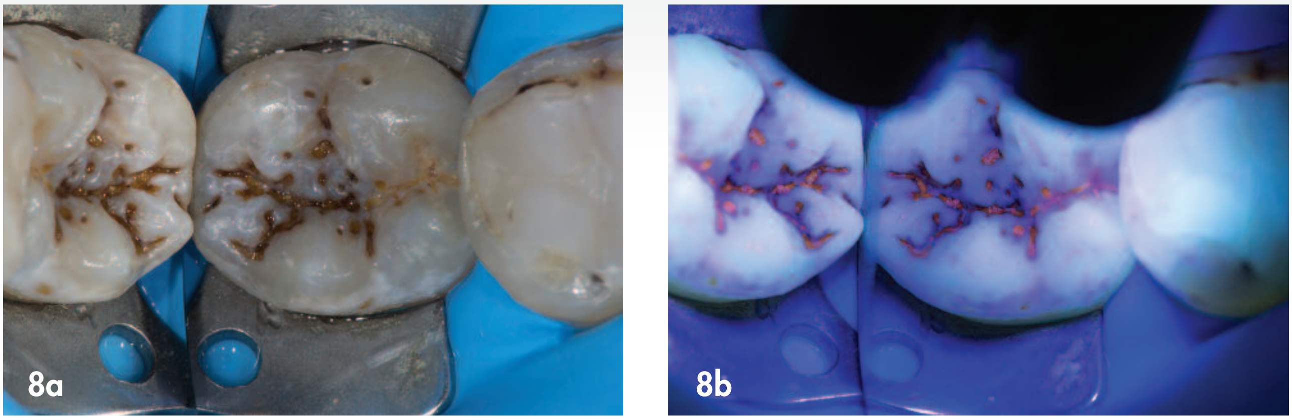


Figure 8a and b: Evaluation of fissure bacterial activity and initial enamel caries (with & without D-Light Pro)

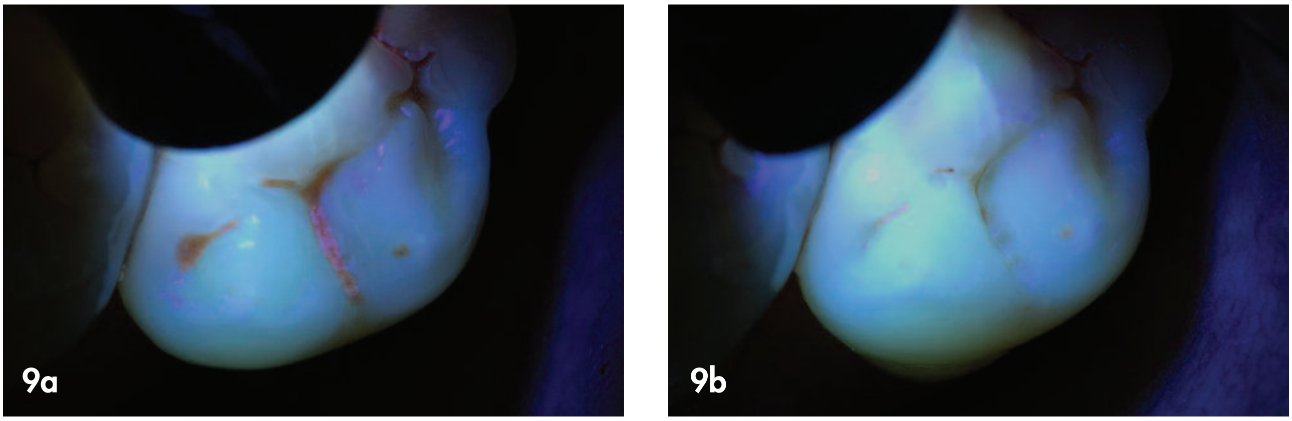


Figure 9a and b: Fissure cleaning control before and after prophylaxis (both with D-Light Pro)

between marginal staining - produced by food stains such as tannins - and micro-leakage - caused by bacterial infiltration - can be a difficult task (Figure 7a). On the contrary, with the near-UV light the difference becomes extremely clear: while a marginal staining will still appear dark, a true micro-leakage will present high bacterial activity and thus exhibit a strong red fluorescence (Figure 7b). In this way the near-UV light unit can be used as a great detection tool in order to define whether to intervene or not in the presence of marginal discoloration of a restoration.

Detection of bacterial activity in fissures

When it comes to evaluating fissures, the process is very similar (Figure 8a). While a natural fissure staining will remain dark under near-UV light, the fissures with plaque and bacterial activity will show a strong red fluorescence (Figure 8b). Even initial caries can be detected in this way, as long as they affect the outer enamel. However, as the penetration of light in the tooth structure and the subsequent fluorescence emission are limited, for deep pits and fissures with underlying caries it is recommended to use other diagnostic tools that make use of longer wavelengths (like infra-red light) to penetrate deeper into the tooth structure and detect underlying caries.

Fissure cleaning control

For achieving a good prognosis with fissure sealing therapy, it is necessary to perform an exhaustive cleaning of the fissure before the application of the sealing agent such as a glass ionomer (i.e GC Fuji Triage) or a flowable composite (i.e GC G-ænial Flo X).

Nevertheless, the control of this cleaning process is not

Figure 10: Suggested minimum intervention fissure sealing treatment workflow

always easy and often we might have doubts whether or not there remains some bacteria in the fissure. With the near-UV light it is easy to identify remaining bacteria through the red fluorescence they emit (Figure 9a & 9b). A workflow using a prophylaxis air-powered device and a near-UV light unit will become extremely useful in order to perform fissure cleaning and subsequently check if the cleaning process was successful (Figure 10).

Detection of fluorescent composite restorations or resin cements

Most modern restorative composites and resin cements contain fluorophores in order to display a natural-looking fluorescence under UV light.

Unexpectedly, those fluorophores are more sensitive to near-UV light than to UV light, producing a stronger blue fluorescence emission when visualized with near-UV light. This enables the identification of otherwise invisible tooth-looking restorations (Figures 11a & 11b) and also becomes handy when removing restorations, overhangs of composite and excesses of cement. Furthermore it can be extremely useful after orthodontic treatment to detect and remove bracket resin cements (provided the specific cement is indeed fluorescent).

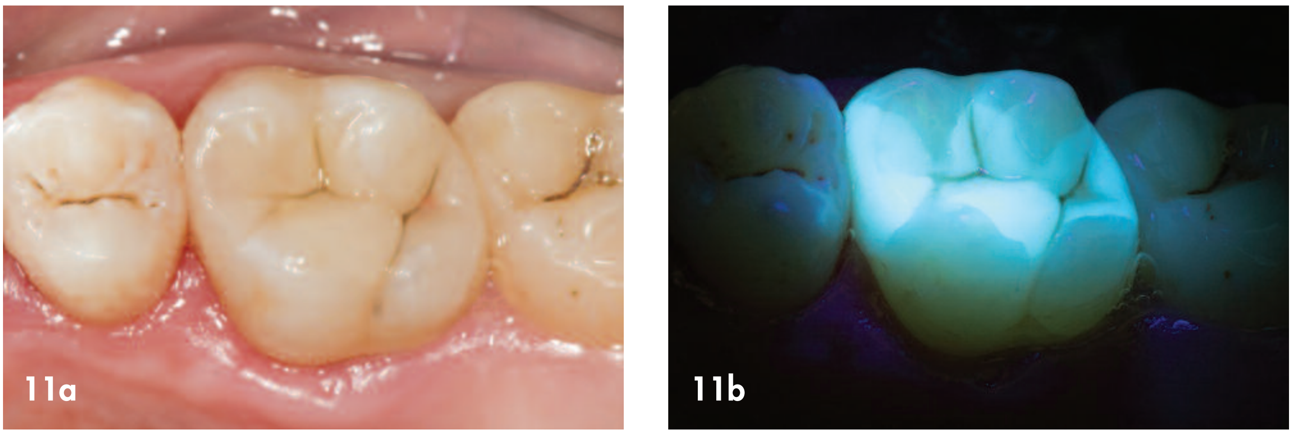
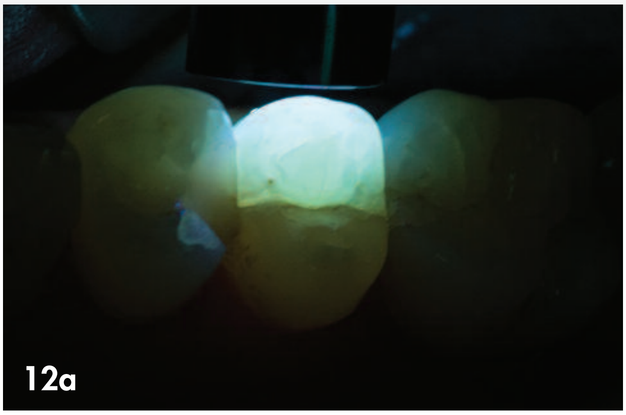


Figure 11a and b: Composite restoration detection (with & without D-Light Pro)



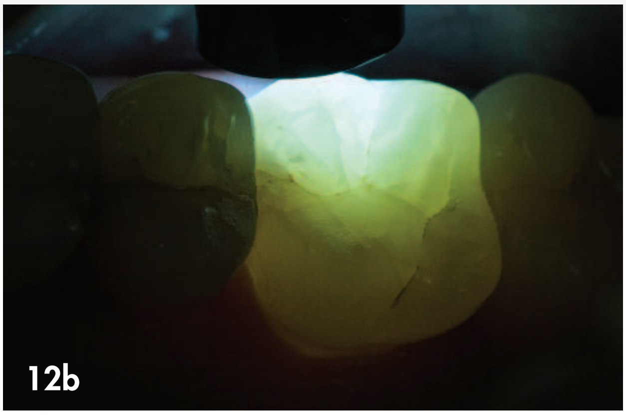


Figure 12a and b: Transillumination and crack detection (both with D-Light Pro)

Transillumination and crack detection

Finally, a medium intensity light - such as the 405nm LED light in the D-Light Pro - allows the use as a transillumination device, helping the detection of proximal caries and especially the detection of cracks. Deep cracks that extend over dentin will block the transmission of the light (Figure 12a), while surface enamel cracks will not block the transmission (Figure 12b).

A crack that blocks the light is a clear signal of alarm for vertical tooth fracture and needs to be treated accordingly. Furthermore, using the bacterial activity indicator through red fluorescence makes it possible to identify widened cracks with bacterial infiltration that need to be treated.

As a conclusion, the use of a medium intensity near-UV light emitting device - such as the GC D-Light Pro - can easily become indispensable in our daily practice due to its huge potential for detection and as a support to establish a diagnosis. It is clear that it deserves a space between our mirror and probe as a standard tool in a modern restorative practice.