



# Prophylaxis camera

## Clinical Booklet

Draft

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# Product Summary

## *A unique view*

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An anatomical view of the tooth in a native fluorescence image allows the viewer to assess the condition of the tissues being observed:

- Up to 100x image magnification
- Chromatic amplification of the endogenous fluorescence alone, which is reproducible and does not require any pseudo colour processing software
- Unrivalled resolution in fluorescence imaging.

## *A prophylactic tool*

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The prophylaxis camera is an effective, multi-purpose device for tissue differentiation in real time, which is dedicated to speeding up dentists' daily diagnostic procedures and early detection of disease symptoms in order to preserve dental structures.

## *A communication aid*

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Improving the oral and dental health of patients relies on the quality of the two-way relationship between dental practitioner and patient. The information gathered by the prophylaxis camera will enable the treatment team to communicate about the patient's individual state of oral health. The first signs of pathology are demonstrated to the patient, the probable progress can be illustrated and the therapeutic measures to be taken in order to halt the disease can be explained. The visual follow-up can motivate patients over time.

This tool is an addition to the range of preventive techniques that enable us to set up the most suitable treatment for each patient.

# Introduction

The clinical examination that features in the diagnostic process in general practice is based on visual information and tactile sensation obtained with the aid of mirror and probe, but these methods have quite limited performance and may even prove traumatic.

Non-invasive diagnostic aids have appeared in recent years. The devices rely on the principles of transillumination, laser and differential quantitative measurement of fluorescence or electrical impedance.

However, their limited field of investigation and constraints on their use make them difficult to integrate into the daily practice of a dental surgery.

Full realization of the needs of practitioners in general dentistry practice combined with the historical expertise of SOPRO in surgical and dental imaging made it possible to develop the prophylaxis camera, a fluorescence imaging system combined with chromatic amplification.

The prophylaxis camera is intended for clinical practice in general dentistry, directed towards preventive concepts, prophylactic care and overall patient management. Its purpose is to tell you about the condition of the tissues on which you are working.

In its three operating modes (Daylight, Prophylaxis, Caries) the system is used live because free from ultra-violet or ionising radiation.

In Prophylaxis mode it informs practitioners about the presence of dental tartar/plaque while simultaneously enabling them to distinguish healthy from diseased gingival tissues.

In Caries mode the camera can be used to observe and show patients a warning sign of enamel and dentinal caries.

This booklet guides practitioners through the discovery of a new approach to communicating with and motivating patients, illustrated through a number of clinical cases.



TECHNOLOGY

## Intraoral video

A core business of SOPRO, the intraoral video combines several areas of expertise: optics, electronics and signal processing as well as micromechanics.

A scene illuminated by optical methods such as LEDs is captured by an image sensor (CCD), electronically processed by specific circuits and directed to imaging or storage devices.

Fluorescence imaging for diagnostic purposes requires a very high image quality. Technology developed by SOPRO in order to achieve this high quality level was the subject of major research work and accompanied by the registration of numerous international patents.

This technology uses native autofluorescence and avoids resorting to software interfaces involving the use of pseudo colours which are subject to approximate interpretation.

## Phenomenon of fluorescence

Fluorescence is light emission produced when molecules present in a classically stable state (solid or liquid) are illuminated by a light source within the UV spectrum (<400 nm) or the visible spectrum (>400 nm). It should be noted that humans see visible light over a spectral band ranging from 400 nm to 700 nm wavelength.

### Principle of the Caries mode

The principle illustrated by the following diagram can be broken down into the following stages:

- The photons (elementary light particles) supplied by an external light source such as a laser or a lamp (with a narrow wavelength bandwidth) shine onto the material(s) of the tooth (enamel and dentine).
- The energy supplied by the excitation source (LED camera) to the material (dentine) causes an increase in the energy of the elementary particles of the material which become highly unstable.
- In order to return to a stable state, they release their excess energy by emitting photons of lower energy than the excitation light and a higher wavelength (Stokes Law). This is the phenomenon of fluorescence.

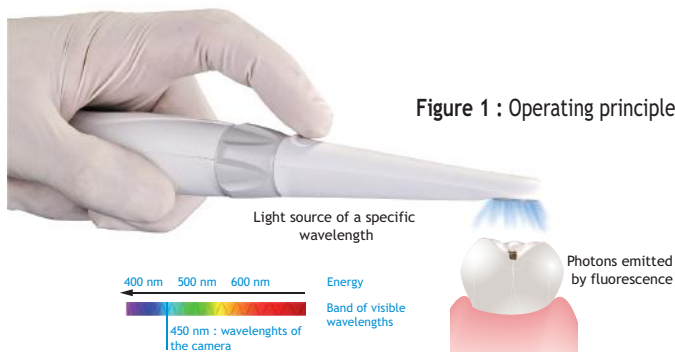


Figure 1 : Operating principle of the camera in Caries mode

## Principle of autofluorescence

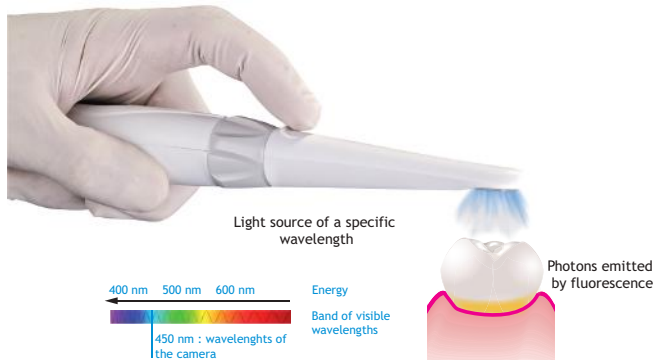
Certain molecules in the body emit a fluorescence without external intervention other than light excitation. This is known as autofluorescence or endogenous fluorescence, to distinguish it from induced or exogenous fluorescence which uses external fluorophores that can be administered systemically or topically.

This is the phenomenon of autofluorescence which is used by the prophylaxis camera. It is based on the stimulation of endogenous fluorophores present in the tissues of the teeth.

This non-invasive imaging can thus be performed without any risk and does not require any exogenous fluorophores, which can sometimes prove toxic and necessitate specific regulation.

## Principle of the Prophylaxis mode

**Figure 2 :** Principe de fonctionnement de la caméra en mode Prophylaxie



The Prophylaxis mode also uses the phenomenon of fluorescence but this time combined with chromatic amplification.

When this mode is in use, the tooth is illuminated with both blue LEDs (for fluorescence) and white LEDs (to maintain the relief) in order to recover the fluorescence emitted in return by food pigments present in dental tartar.

To highlight gingival inflammations, the prophylaxis camera uses only the settings of chromatic amplification to enhance this pathology.

## “Prophylaxis camera” concept

Dental prophylaxis is the active or passive process which aims to prevent and therefore stop the appearance or spread of a disease. Its universal principle nowadays is to avoid damage by the early detection of pathological symptoms and minimally invasive restoration while treating the cause.

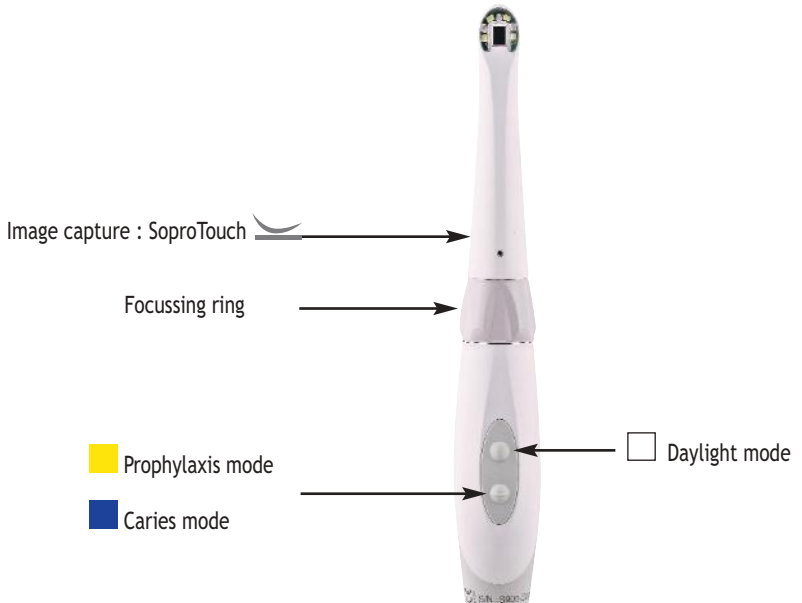
It starts first of all with the patient’s realization of the importance of his cooperation in maintaining his health. A patient who is aware of his oral and dental health will thus be more likely to grasp and accept the necessary treatment plan that is set up.

The general concept of prophylaxis therefore hinges on communication with the patient in order to motivate and educate him about his oral hygiene after the dental practitioner has quickly performed an individual, complete periodontal and caries check-up.

To assist dentist and/or hygienist in their preventive care and visual diagnostics, the prophylaxis camera offers three distinct operating modes:

- In Daylight mode (represented by a white square on the image), the camera allows the user to visualise anatomical details that are invisible to the naked eye or with a mirror.
- In Prophylaxis mode (represented by a yellow square on the image), the camera helps the practitioner to visualise the presence of dental plaque and tartar but also reveals gingival inflammation alongside these deposits.
- In Caries mode (represented by a blue square on the image), the camera alerts the practitioner to the presence of fissure caries on the occlusal surface of the teeth.

Figure 3 : Three operating modes of the camera







CLINICAL

# Dental plaque and tartar

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## Definition

Dental plaque is a biofilm made up of an enormous number of bacteria together with cell debris, saliva and food residues. It is continually being formed on the tooth surface, especially after meals, and it is known as tartar once it becomes mineralised.



**Figure 4 :** Dental plaque and tartar

Plaque may then be compared to a milky layer that adheres to the tooth and can easily be removed by the use of a toothbrush. Tartar, on the other hand, presents a rough surface and can only be got rid of by mechanical action such as that of ultrasound.

## Methods for detecting these deposits

### 1 - Clinical inspection

The aim of visual diagnostics is to inspect all the surfaces (labial, buccal, interproximal, lingual or palatal) of a tooth in order to detect any plaque and/or tartar that may be present.

Even under the best conditions (use of a mirror, good lighting by shadowless lamp, etc.) visual inspection is still difficult to perform, especially for posterior sites, and it generally requires the use of a probe to scratch the tooth surface and thereby pick up deposits if any are present.

### 2 - Plaque disclosing solution

The plaque disclosing solution consists of a mouthwash containing a dye in liquid or tablet form that reacts on contact with deposits and thus reveals the places where dental plaque persists after cleaning. This means the patient's brushing technique can be corrected because it reveals the areas that are forgotten or neglected.

However, this solution is being used less and less in clinical practice because it takes a long time to apply and therefore increases the time the patient spends in the chair. The resulting staining can sometimes be embarrassing for the patient and, after use of the plaque disclosing solution, the dentist has to carry out prophylactic cleaning in order to get rid of the discoloration. Furthermore, the results are dependent on application of the plaque disclosing solution. There is also a possibility of certain allergies and an unpleasant taste.

# Gingival inflammation

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## Definition

As the bacteria present in dental plaque and/or tartar are foreign bodies, they represent an attack and trigger a defensive reaction from the gum. This reaction takes the form of visible inflammation due to the influx of blood induced in order to bring the immune defensive cells to the site of the attack.



Healthy gum



Gingival inflammation

**Figure 5 : Gum**

Healthy gums have a pale pink, “orange peel” appearance and do not bleed on contact with the probe.

In the case of inflammation, the gum becomes red, smooth and swollen even if all these symptoms are not necessarily present simultaneously during this disease. The inflammation bleeds readily, either during brushing, during use of the probe or sometimes even spontaneously.

Changes in colour, consistency, texture, volume and contour of the gum will therefore be observed.

## Methods for diagnosing gingival inflammation

### 1 - Clinical inspection

The aim of visual diagnostics is to assess the four cardinal signs of inflammation: redness, oedema, heat and pain.

Even under the best conditions (use of mirror, lighting by shadowless lamp, etc.), visual inspection is still difficult to carry out, especially for the posterior teeth.

### 2 - Gingival bleeding

Gingival bleeding is regarded as a revelatory sign of gingival inflammation, which is extremely early and far more precise than redness of the tissues. Conversely, cessation of bleeding is seen as evidence of reduction of gingival inflammation and a sign of repair. However, no conclusions about the progress of the disease can be drawn from an absence of bleeding and there may still be inflammation without necessarily causing any bleeding.

The bleeding is assessed by the use of a probe, a painful instrument for the patient and not very reliable from one site to another because it is dependent on the pressure exerted at each site, which varies from one practitioner to another.

### 3 - Biological and bacterial tests

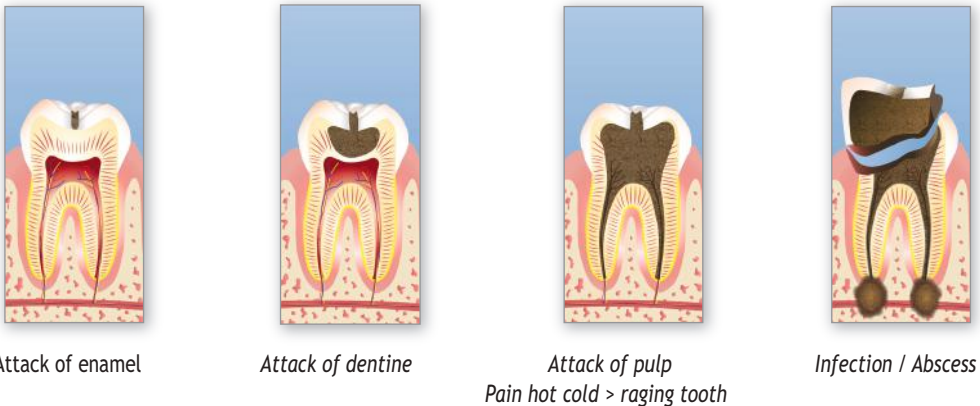
There are biological and bacterial tests that can be used to confirm the presence of gingival inflammation while analysing the bacterial flora present at the site. However, these tests are very expensive and lengthy to set up in practice (collecting samples from inflamed sites and healthy sites, followed by laboratory analyses).

## Cariou lesions

### Definition

Dental caries is a localised process of bacterial origin which leads to demineralisation of the hard dental tissues. It affects the enamel, dentine and cementum to varying degrees. As the caries advances, a cavity will force a path towards the interior of the tooth until it reaches the nerve. If no intervention takes place, the carious lesion may lead to total destruction of the tooth.

**Figure 6 :** Progression of caries



The tooth's defensive mechanisms, directly linked to odontoblasts which are cells responsible for the production of dentine, are triggered when an external attack is perceived. These cells are found directly at the interface between the pulp and dentine. Their extension to inside the dentinal tubules makes them extremely sensitive in terms of detecting attack. They react in a more or less orderly way when an acid front appears beyond the barrier formed by the enamel, or when bacteria penetrate as far as the dentine and launch the process of destruction of mineralised tissues.

Once the carious process is highly active, dramatic progression of a carious lesion does not leave the odontoblasts enough time to produce sclerotic dentine with the purpose of isolating the pulp from the carious process. However, reparative dentine or atubular fibrodentine is synthesized.

When the carious process is slower, the odontoblasts manage to produce this sclerotic, intratubular and peripulpal dentine.

## Methods for diagnosing carious lesion

### 1 - Caries risk

The risk of caries is defined by a whole set of criteria together with the environment and the patient's physiology (dietary habits, hygiene, oral flora, salivary pH, socio-economic status, etc.). Assessment of the risk is the first step in the diagnostic process.

### 2 - Clinical inspection

The aim of visual diagnostics is to detect any opacity, staining or change of translucency with or without drying.

On clean teeth, the use of a mirror and appropriate magnification aids, under good lighting conditions, will optimise the visual inspection but does not prevent the diagnosis from remaining subjective and constrained by difficulty of access to certain areas and the lack of lighting in the posterior areas.

It should be added that the morphology and discolorations that may be observed in the fissures are not automatically signs of caries.

### 3 - Probing

Dependent on the geometric characteristics of the probe and the fissure anatomy, this method does not provide a reliable indication of the presence of a lesion in the area being examined.

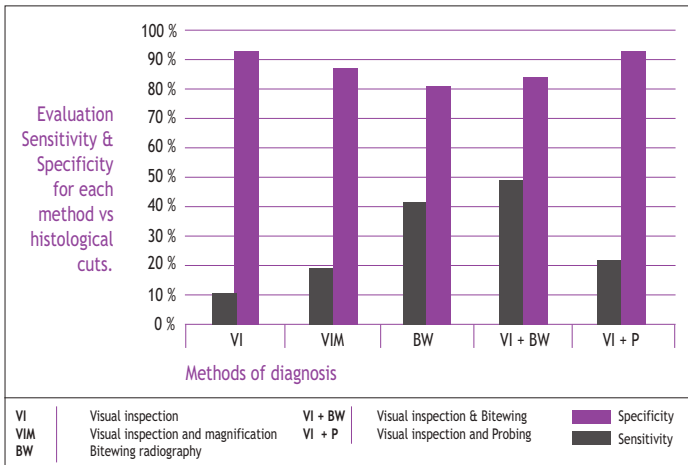
Furthermore, probing may prove traumatic in an area of enamel that has an intact surface but a weakened subsurface.

In addition, probing can also play a part in transporting bacteria from one site to another.

Diagnosing carious lesions on occlusal surfaces is hence a challenge for the dentist and, in the absence of cavitation, the performance of the two above-mentioned methods is generally poor. In any case, visual inspection with the aid of an intraoral camera would improve decision-making and provide better guidance on treatment choices.

### 4 - Conventional radiograph

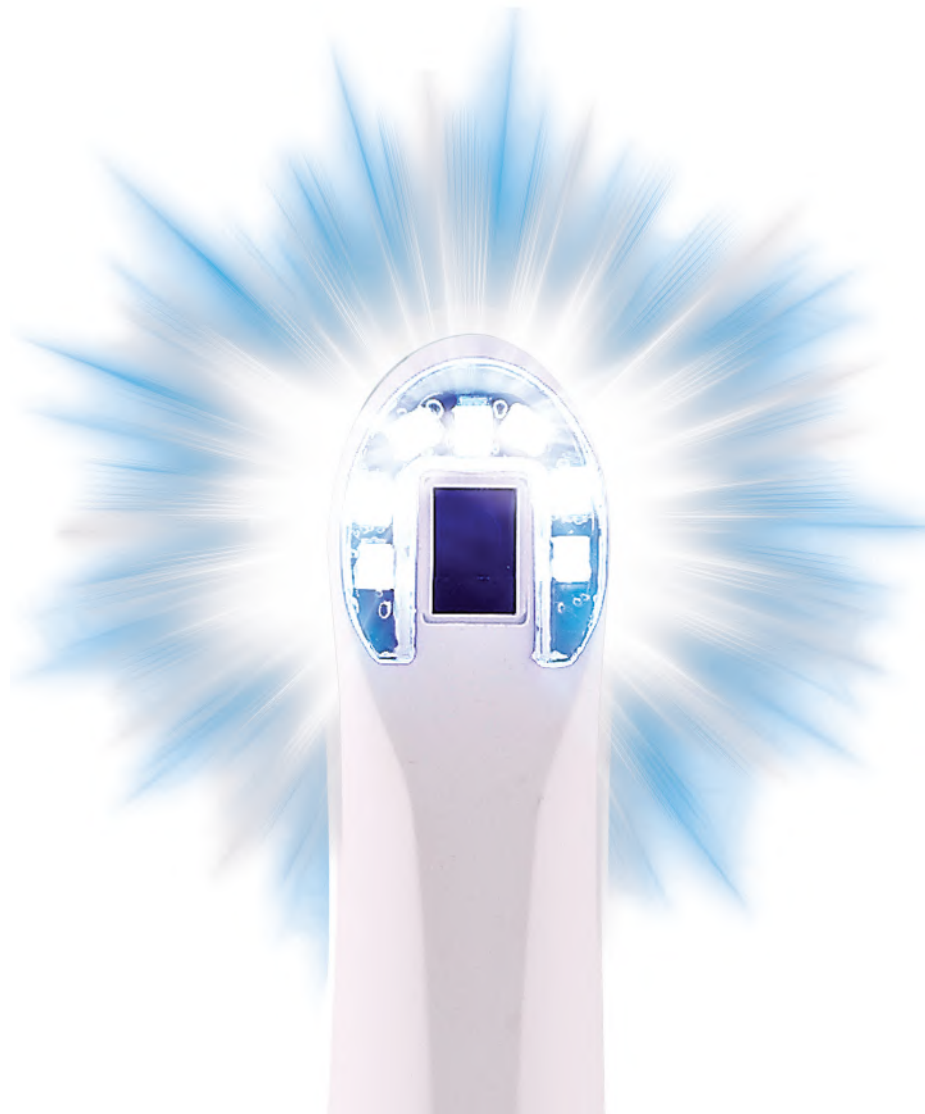
Enamel and dentine are masses with a high density. This is why occlusally a conventional X-ray offers poor sensitivity for enamel lesions (45% alone and 49% in combination with visual inspection), as shown in the study conducted by Lussi in 1993 regarding methods for detecting fissure caries without macroscopic cavitation. By contrast, the specificity of conventional radiographs remains quite high (83% to 90% in combination with visual inspection).



*Comparison of the precision of different methods for diagnosing fissure caries*

Proximally, radiography is currently the most effective diagnostic tool for detecting enamel or dentine damage on bitewing films. Its sensitivity is between 71% and 100%. It depends on the location of the suspected lesion (proximal, labial, buccal, palatal or lingual). Its specificity is between 99% and 100%.

It should also be remembered that radiographs greatly underestimate the size of lesions in terms of depth and stage of progression.



PRODUCT MAKE-UP

## Camera and its accessories

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- 1 Handpiece
- 2 Distal tip
- 3 Handpiece holder
- 4 Docking station





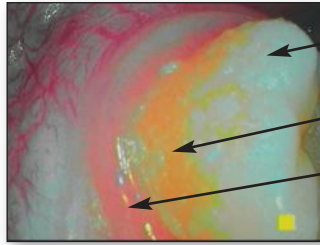
DECISION MAKING DIAGRAMS

Over the following pages, the clinical situations most commonly encountered when performing prophylaxis are explained in order to show that the prophylaxis camera helps dentists to position themselves in the “ideal therapeutic gradient” (concept of Tirlet and Attal).

## Case study n° 1



□ Daylight mode



■ Prophylaxis mode

White: dental plaque

Orange: tartar

Purplish pink border:  
slight gingival  
inflammation

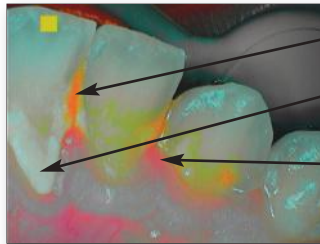
As dental plaque does not fluoresce, under blue light it will keep a whitish colouring rendered slightly bluish by the LED illumination of the camera.

**Treatment decision:** prophylactic cleaning of the site and hygiene advice.

## Case study n° 2



□ Daylight mode



■ Prophylaxis mode

Orange: tartar

White: dental plaque

Purplish pink papillae:  
slight gingival  
inflammation

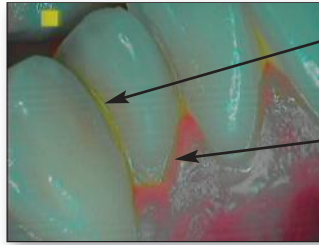
As a function of the patient’s age but also his/her dietary habits (tea, coffee, smoking, etc.), the colouring of the dental plaque and tartar may differ from one patient to another but also from one country to another.

**Treatment decision:** scaling of the site and hygiene advice.

### Case study n°3



Daylight mode



Yellow: tartar

Purplish pink border:  
slight gingival  
inflammation

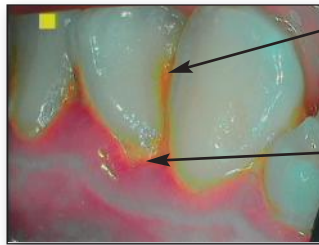
Prophylaxis mode

Treatment decision: scaling of the site and hygiene advice.

### Case study n°4



Daylight mode



Orange: tartar in  
interproximal space and  
at the neck of the teeth

Papillae and purplish  
red border: severe  
gingival inflammation

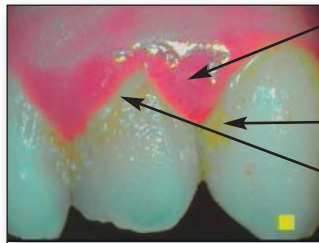
Prophylaxis mode

Treatment decision: scaling of the site and hygiene advice.

### Case study n°5



Daylight mode



Papillae and purplish  
red border: severe  
gingival inflammation

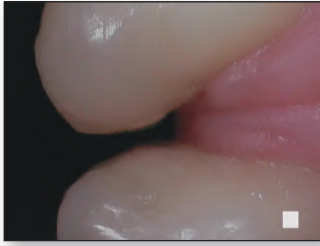
Yellow: tartar

White: dental plaque

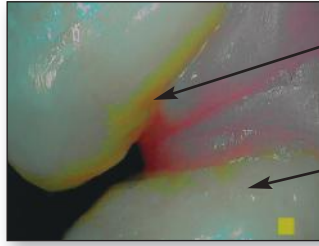
Prophylaxis mode

Treatment decision: scaling of the site and hygiene advice.

## Case study n°6



Daylight mode

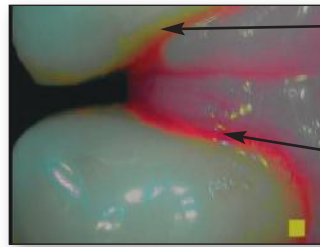


Prophyllaxis mode

Yellow: tartar

White: dental plaque

After a prophylactic cleaning



Prophyllaxis mode

Slight yellow colouring:  
absence of tartar on the  
tooth surface

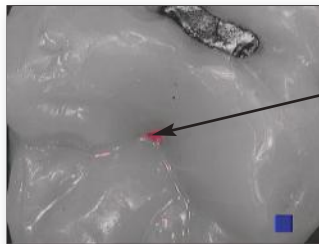
Fluorescent red/pink:  
blood due to the  
prophylactic cleaning

A slight yellow colouring persists after cleaning because food pigments contained in the deposits have penetrated into the enamel.

## Case study n°7



Daylight mode



Caries mode

Red signal in fissure:  
warning of enamo-  
dental caries

If there is a warning signal, professional prophylactic cleaning must always be carried out. The examination should then be repeated.

