Establishing a natural-like fluorescence in zirconia for restorative dental applications

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INTRODUCTION
The optical impression of the human tooth is also affected by the fluorescence of the dentine. To imitate the visual appearance of the natural tooth, fully anatomical restorations are shaded based on a color key. If the fluorescence effect is neglected, restorations can optically differ from the natural teeth in sunlight or in light from artificial sources with a high amount of UV radiation (see Fig. 1). Different products for the incorporation of a fluorescence effect are available on the market. In contrast to veneering materials and glass-ceramics, the results produced in zirconia ceramics are unsatisfactory. The application in dental restorations results in numerous challenging requirements to the used phosphor compounds.

CONCEPT
In this project, different approaches for the incorporation of the desired fluorescence effect in zirconia were assessed. Multiple phosphors were chosen from literature which should express appropriate photoluminescence (PL) properties to mimic the fluorescence of the natural human tooth. Different doping methods were used to incorporate the phosphors into the zirconia. Further, the resulting optical, chemical and mechanical properties of the ceramic were investigated. Samples with commercially available products were produced to allow comparisons.

RESULTS
Conventional yttria stabilized zirconia (YSZ) did not show an emission when excited with 365nm light (see Fig. 2). Porous zirconia was infiltrated with a liquid bismuth nitrate solution before sintering. With this approach a whitish-blue luminescence very similar to human tooth could be generated when excited with 365nm light. The luminescence emission intensity could be influenced by the variation of the solution concentration. An excitation was possible in the whole UV spectrum with an excitation maximum at 322nm for the emission wavelength of 460nm.

CONCLUSION
The evaluation of the selected phosphors showed that bismuth doped yttria and zirconia as well as blue phosphor are the most appropriate phosphors to imitate natural tooth fluorescence regarding the luminescence properties.

REFERENCES