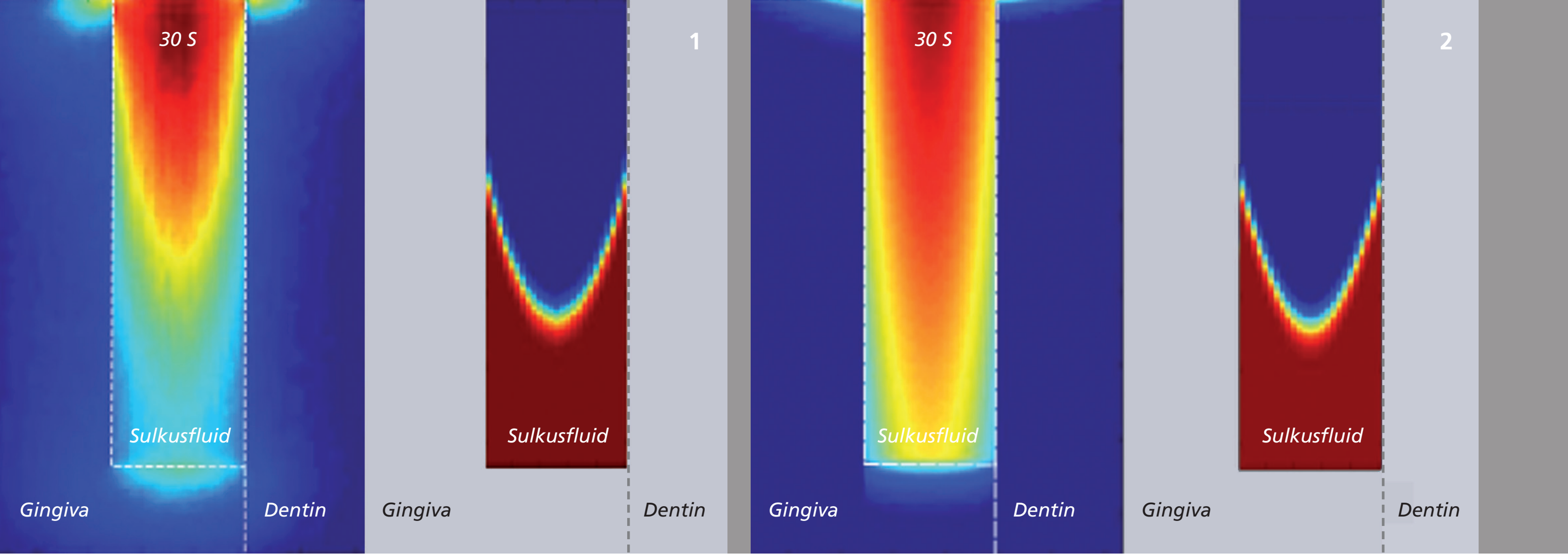

Subject to alterations in specifications and other technical information. 09/2014.

SIMULATION OF ANTIMICROBIAL PHOTO-DYNAMIC THERAPY

Task

Antimicrobial photodynamic therapy (aPDT) can be an effective way of treating local bacterial infections, but whose further development is inhibited because therapeutic success cannot be observed during and immediately after treatment. Mathematical models and their numerical implementation represent a promising tool to identify measurable quantities in order to observe the course of therapy.

Method

Fraunhofer ILT has already developed a simulation code that describes the physical and chemical processes occurring in aPDT. Mathematical model reduction is being used to improve this code to such an extent that many simulations are feasible at an acceptable computational cost. By making use of those simulation runs, scientists can develop strategies to observe the desired treatment progress.

Result

The result consists of a spatially two-dimensional dynamic model, which describes the time-resolved propagation of the successfully treated area. The results show that the distribution of the laser intensity (as an initiator for the chemical reactions) and the flow of the chemical reactions (by changing the optical properties) are mutually dependent upon each other. In comparison to the existing numerical model, the reduction is such that the coupled processes between beam propagation and chemical reactions are resolved in one-dimensional strips, which are joined to form a two-dimensional simulation subsequent to the calculation.

Applications

The model Fraunhofer ILT has developed is oriented toward treating periodontitis with aPDT. Other promising applications are the treatment of wound infections or of local infections with multiresistant bacteria, photodynamic therapy for tumor treatment as well as photo-immunotherapy, by which the active ingredient is bound to the target cells by antibodies.

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Distribution of intensity and successfully treated area
1 ... from the numerical model after 30 s.
2 ... from the reduced model after 30 s.

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