



Latest news

- HATZ becomes a full member of Euro-CASE
- HATZ officially recognized as scientific organization
- Agreement signed between HATZ and Austrian Academy of Sciences
- Milan Bandić, Mayor of Zagreb, accepts co-patronage of Ruder Bošković's tricentennial



CAETS

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New Technology

Photonic Crystals – Enabling Optical Signal Processing

In recent decades, electronics has demonstrated enormous success in advancing almost any application that has to do with information processing: following Moore's law, data density on an electronic chip has doubled every 18 months. Although such an exponential growth is likely to continue for a while, inherent physical limitations of electronics are expected to prevent this growth from lasting indefinitely. Some of these limitations are already becoming manifest today: as electronics in modern computers is forced to operate at ever-higher frequencies, power dissipation and consequent hardware heating are becoming a very serious problem. In nodes of optical telecommunication networks, where data needs to be processed electronically at operational frequencies that are even higher, the problem is even more eminent. Electronics is simply not suitable for operation at very high frequencies, or bandwidths.

Realizing that electronic signal processing would eventually face this fundamental physical limitation, engineers in the early 80s enthusiastically explored the possibility of building an optical computer, in which data would be carried with light (photons) instead of charged carriers. Optical domain is perfectly suited for operation at high frequencies, with physical limits orders of magnitude higher than those of electronics. However, for true all-optical signal processing, one has to have a way of influencing light with light itself: one has to use optical nonlinearities. In optically nonlinear media, the index of refraction is modified by the presence of a light signal; this modification can be explored to influence another light signal, thereby performing an all-optical signal processing operation. In order to efficiently operate at high speeds, one prefers to use nonlinearities with ultra-fast (or nearly instantaneous) response and recovery times. Unfortunately, such nonlinearities are extraordinarily weak, so the proposed optical logi-



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cal elements from the 80s were too large, and consumed orders of magnitude too much power to be feasible. Since electronic computers of the time were still far from their physical limits, the research in the area of optical computing dramatically subsided in the years that followed, and people started viewing optical signal processing as being impractical due to the weakness of the optical nonlinearities.

Since those days, the limits of electronics have become much more pressing,

and to mitigate the problems associated with them, engineers have recently started resorting to optics again. In optical telecommunication networks engineers nowadays try to minimize the involvement of electronics in signal manipulation and to keep the signals in the optical domain for as long as possible. Furthermore, even data transport between various electronic desktop computer parts (e.g. between different parts of the processor, between the memory and the processor, etc.) will likely soon be performed in the optical domain. Therefore, there is a rapidly growing need to find new physical mechanisms that would improve our ability to manipulate light. In the quest for the optimal solution, photonic crystals (first invented

in 1987) have recently emerged as an exceptionally promising platform.

Photonic crystals (PhCs) are artificially created materials in which index of refraction varies periodically between high index regions, and low index regions. Such an environment presents to photons what a periodic crystalline potential of a semi-conductor presents to electrons. In particular, under proper conditions, a complete photonic bandgap opens: light for any frequency within the photonic bandgap is prohibited from propagation in any direction inside a PhC. Because of these similarities, PhCs are sometimes called "semiconductors for photons". Since semiconductors enabled integration of electronics, PhCs are thought to be the most promising candidate to implement integrated optics. PhCs offer unprecedented opportunities for molding the flow of light, so geometrical properties of PhC devices can dramatically enhance optical interactions of interest. For example, preliminary nonlinear PhC all-optical switches have been built that are of sub-micron size, an order of magnitude faster than transistors used in commercial electronics today, while consuming only two orders of magnitude more energy per logic operation. Moreover, PhC designs that could enable nonlinear interaction even between single photons have been proposed. Nonlinear PhCs are thus destined to dramatically change the view that optical nonlinearities are too weak to use for signal processing.

In the years that will follow, one should expect optics solutions to keep penetrating deeper and deeper into electronic designs, and PhCs will play a major role in making this possible: information processing of the near future will thus likely be performed by hybrid electronic and optical designs, with optics playing an ever-increasingly important role.

Upcoming Meetings

CROATIAN GENETIC SOCIETY
3rd CONGRESS OF CROATIAN GENETICISTS
with international participation

Primošten, Croatia
June 6-9, 2010

FIRST ANNOUNCEMENT



Sponsored by:
Ministry of Science, Education and Sports
Faculty of Food Technology and Biotechnology,
Zagreb

Under the Auspices of:
The Croatian Academy of Science and Arts
The Croatian Academy of Engineering

For further information contact
the Organizing Committee

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ORGANIZIRAJU
ZNANSTVENO-STRUČNI SKUP
s međunarodnim sudjelovanjem



**TEHNOLOGIJE
ZBRINJAVANJA
OTPADA I ZAŠTITE TLA**

18. - 21. listopada 2009.
Hotel "Funimation"
Hotel "Donat"
Borik, Zadar

CILJ SKUPA

Od ovog znanstveno-stručnog skupa očekuju se ocjene stanja i mogućnosti te smjernice poželjnih, gospodarski, socijalno i ekološki održivih, a u praksi provodljivih tehnoloških rješenja zbrinjavanja otpada, koja uključuju zaštitu tla i svih članova „ekološke trijade“. Ovaj Skup Hrvatsku približava uvrštavanju među poželjne pripadnike europske zajednice naroda i pažnje vrijednog gospodarskog partnera, čiji će se glas čuti i uvažavati u okviru zajednice naroda koju danas čini EU.

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