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Nonlinear Optical Effect of Natural Dyes Extracted from Hibiscus Sabdariffa with its Application as an All-Photonic Switching

Nonlinear Optical Effect of Natural Dyes Extracted from Hibiscus Sabdariffa with its Application as an All-Photonic Switching

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Introduction- There is an important interest and research work being undertaken by various research groups worldwide on natural dye applications due to its friendly environment and the viability and the high potential of these dyes to be used as optical materials for industrial and scientific applications. Indeed, there is a need interesting in developing green novel hybrid photonics. All-photonic devices, in which photons instead of electrons are used as information carriers, represent the wave of the future in all-optical communications and information processing, that is required to modulate the signal light by using a pump laser beam. But, the interaction between photons is only possible in an optical material. Natural dyes can be introduced as new optical materials. The nonlinearity effect can be used for the design of all- photonic devices. In this stage, all-photonic devices can be used as a core element in constructing on-chip all-optical switch networks [1-4].

Experimental- Natural dyes extract of Hibiscus Sabdariffa (Hs) has been used for dyeing natural materials. Hs and Hs/PVA freestanding film were prepared under a simple physical method. This method is called the simple aqueous extraction method [5] (more detail will be described in the text). In this contact, we have presented and built pump-probe technique to demonstrate the possibility of realizing the all-photonic switching of Hs and Hs/PVA freestanding films.

Results and discussion- The absorption spectra of the sample freestanding films was measured using UV-visible spectrophotometer in the range of 200-800 nm. It was observed that the sample have absorbance peak at 550 nm. In addition, we studied the effect of nonlinear optical response for Hs and Hs/PVA freestanding films. Here, different nonlinear optical parameters such as the nonlinear refractive index n_2 and nonlinear absorption β were determined. From the absorption coefficients α and the nonlinear optical parameters n_2 and β of these dyes, two all-optical figures of merit $W=n_2I/\alpha\lambda$ and $T=\beta\lambda/n_2$ (I is the intensity of laser beam and λ the wavelength of laser) has been given to assess the possibility of using the natural dyes in all-photonic devices. Note that, it is shown that the all-figures of merit for Hs/PVA are higher and optimal values as compared to the Hs dye at input power. The result confirmed that the Hs/PVA can be a promising material for using to fabricate all-photonic devices.

To achieve high performance all-photonic devices of the natural dyes, different parameters are needed [1]. These parameters are the low input power, high switching contrast (SC), large modulation depth (MD), and fast switching time (ST). The devices with high MD and SC and fast ST with optimum power for Hs/PVA were achieved.

Conclusions- The results confirmed that the presented and built pump-probe technique was effective and able to pump the natural dyes and control the parameters (MD, SC, and ST). Natural dyes extracted from the Hibiscus Sabdariffa were used as natural photonic media for all-photonic devices. The all-photonic devices based on Hs/PVA have shown the best performance. The obtained results could open the way for further and

future prospective studies among natural dyes with nanomaterial or other dyes in developing all-photonic devices and using as sensitizers for solar cell devices.

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