Perfect plasmonic absorber for visible frequency

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5 nm

INTRODUCTION

Plasmonic Metamaterials (PM) with their exotic properties drawn the attention considerably in the last decade for number of applications such as negative refractive index, nano-laser and photovoltaics [1] amongst others. In spite of early consideration of loss as a foremost drawback of PM, the absorptivity is started to be considered as one of the new potential function of PM following the first experimental demonstration of PM perfect absorber (PMPA) [2]. However, lithographically fabricated PMPA showing narrow band-width and are sensitive to the angle of incidence which make their application very limited. Here, we show that ultra thin film of metal-dielectric nanocomposite deposited by co-sputtering on highly reflecting mirror could act as a wide-band perfect absorber for different frequency [3-5]. This approach is enjoying ease of fabrication, low production cost and high efficiency in the sense of absorption intensity, band-width and angular sensitivity and hence could be implemented in micro/nanofabrication industry.

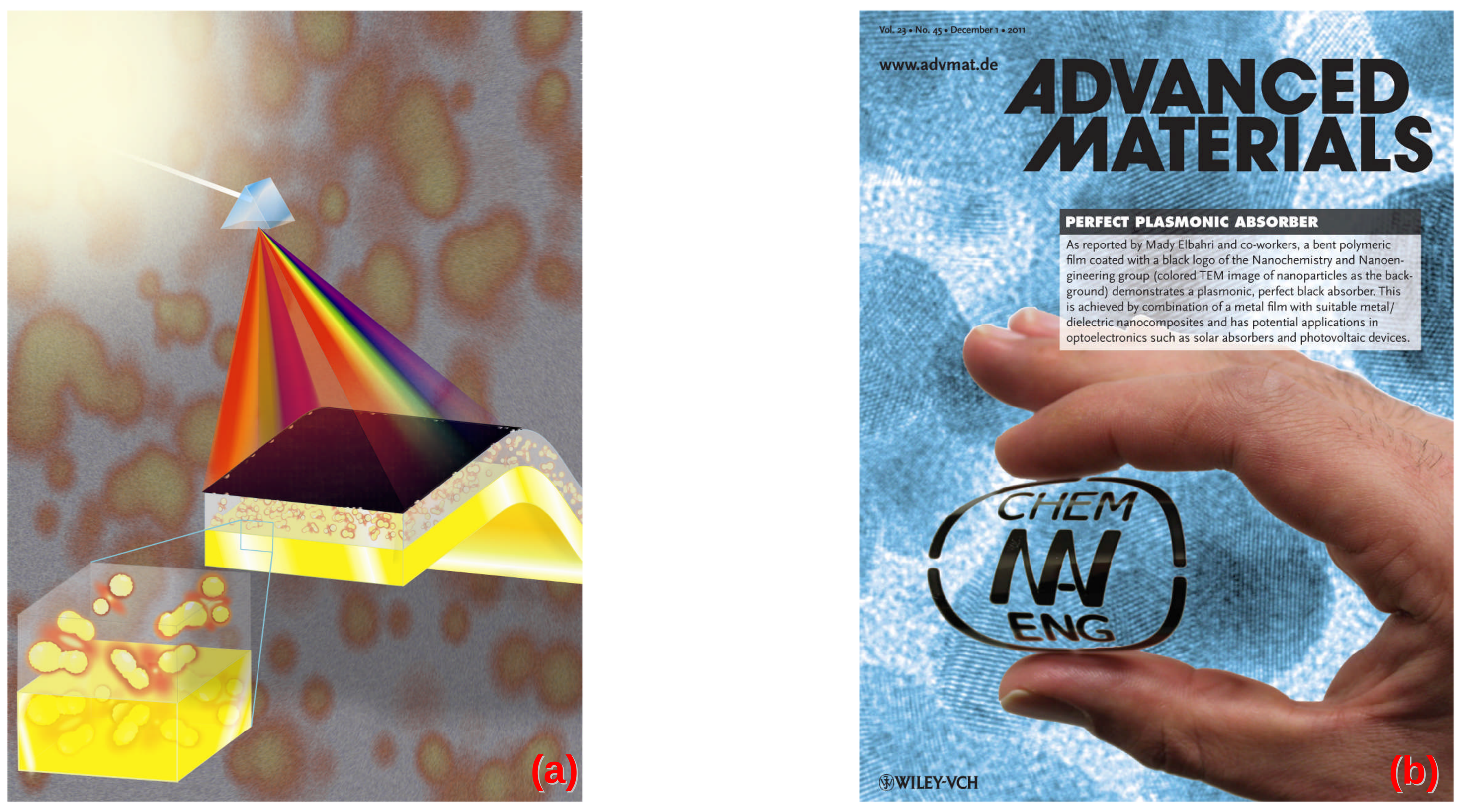

Figure 1: (a) Schematic of the structure used in our previous work. (b) Perfect black absorber coated on a flexible polymer substrate which was highlighted in Advanced Materials as the Frontispiece [6].

MATERIALS & METHODS

By two magnetrons with an angle of 50°, co-sputtering was done in order to make a nanocomposite. (Figure 2 (a)). For acquiring a homogeneous thickness for the film and uniform dispersion of metals, all depositions were carried out on the substrates attached to a rotatable holder. The spin coating (c.f. Figure 2b) for preparation of Polystyrene - Spirophenanthrooxazine composite films (details can be found in our earlier work [7]) was carried out with Spincoater (P6700 Series).

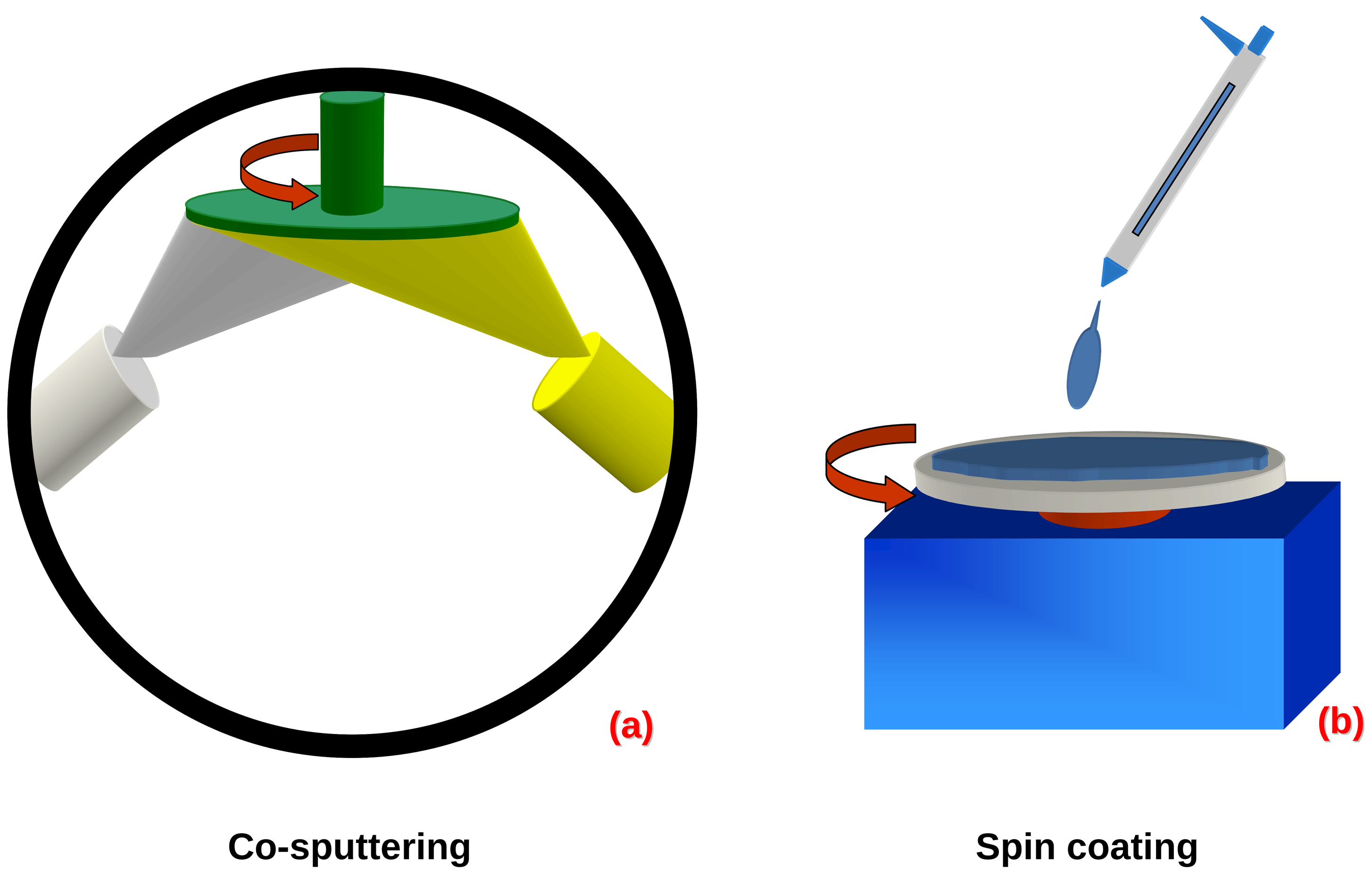

Figure 2: Schematic of (a) the inner cylinder of sputtering process where two magnetrons are running simultaneously for co-sputtering and (b) Spincoating process which was used for PS(SPO) deposition.

RESULTS

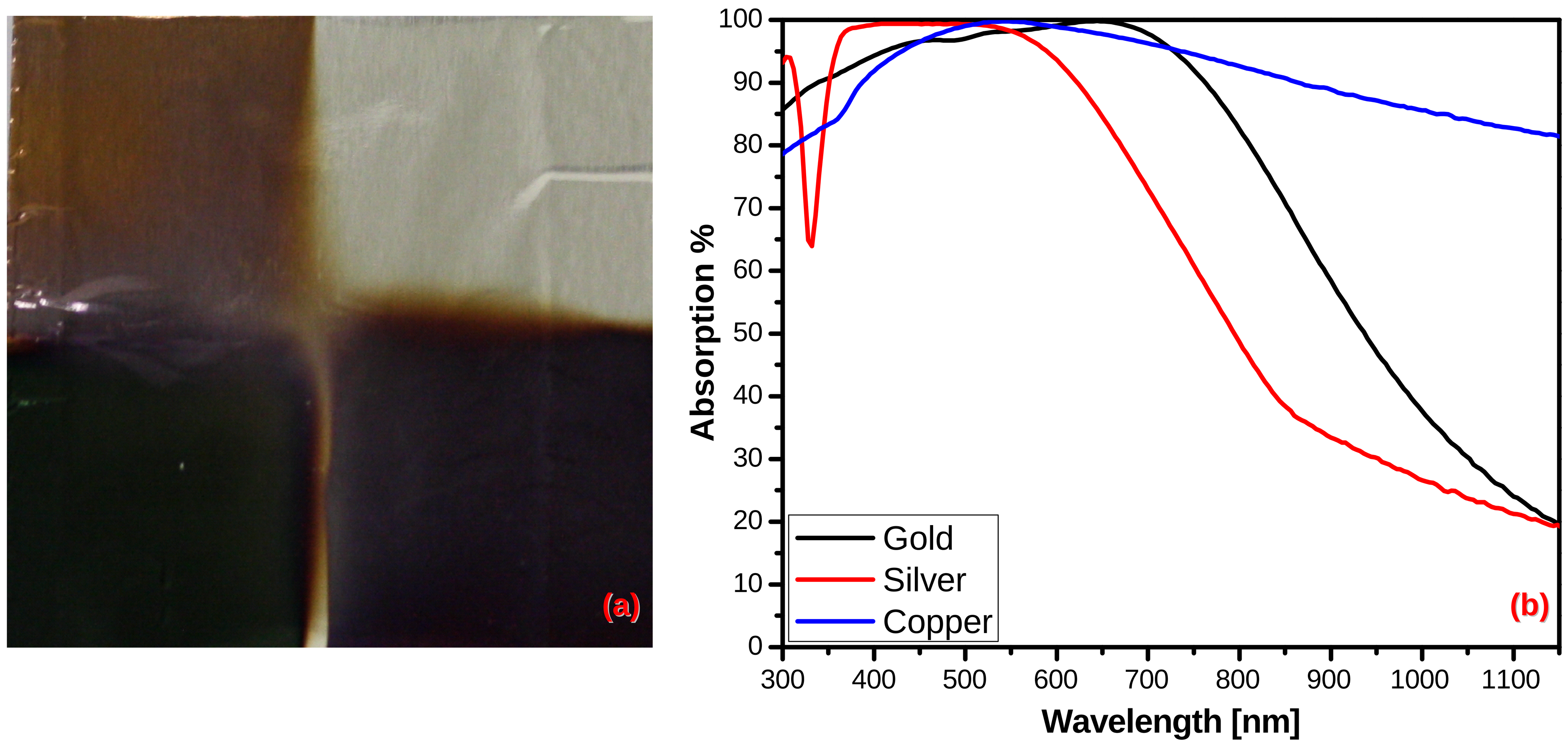

Figure 3: (a) Aluminum foil which is coated with 50nm Au-SiO_2 nanocomposite with different filling factor. Correspondingly, from top left (13%), top right (no coating), bottom left (30%) and bottom right (20%). (b) Absorption spectra of nanocomposite out of gold (black), silver (red) and copper (blue) on gold, silver and copper film, respectively.

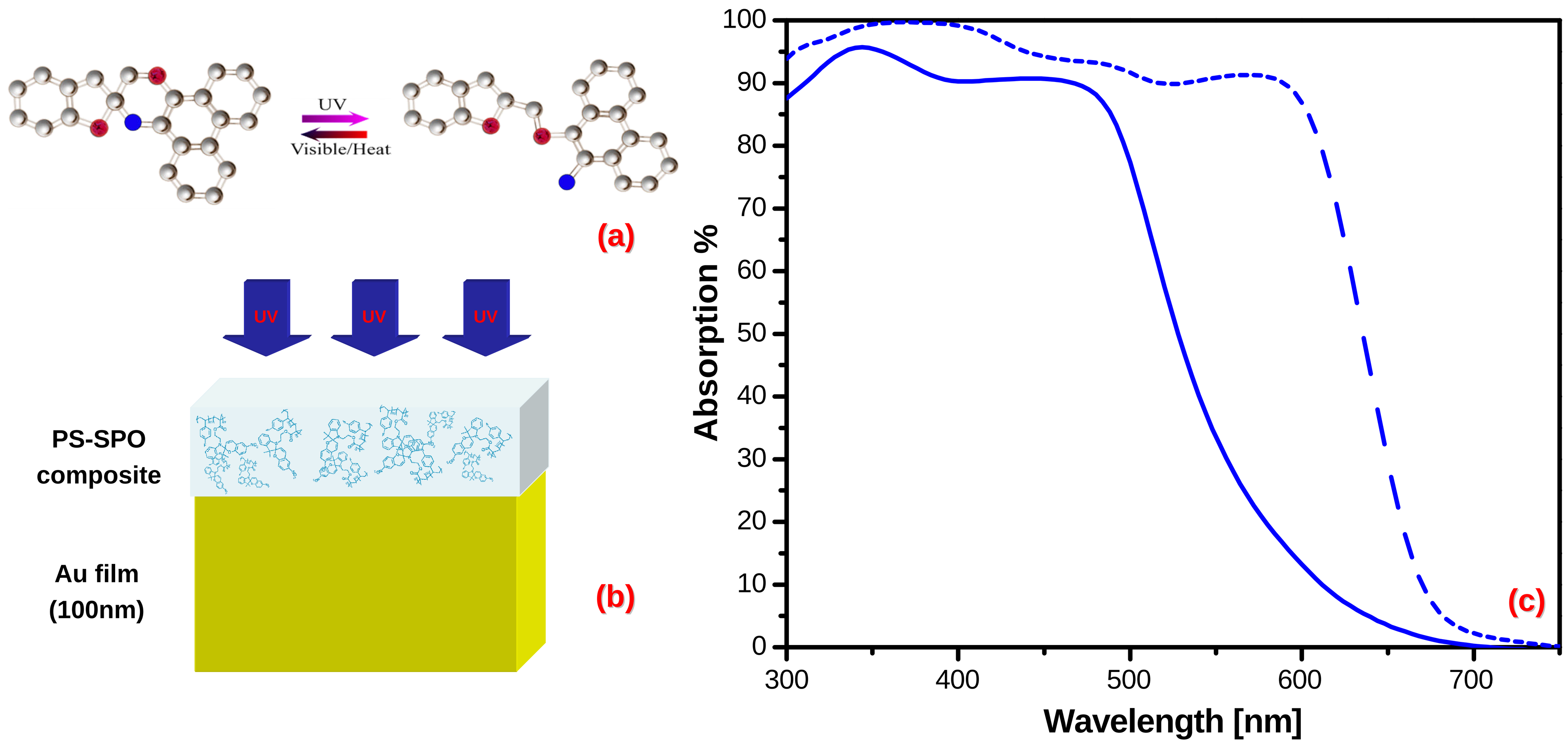

Figure 4: (a) General structure of Spirooxazine molecules which changes its coloration upon irradiation by UV or visible light. (b) Schematic of the photoswitchable perfect absorber consisted of thin layer of Polystyrene-SPO composite deposited on 100nm gold film. (c) Typical absorption spectra of (b) where solid and dashed lines are the absorption in off-state (visible irradiated) and on-state (after the UV irradiation) [8].

SUMMARY

In this work, plasmonic nanocomposite is presented as a new class of metamaterials perfect absorber. This coating can be deposited on any type of substrates and its absorption band and intensity can be tuned by changing the thickness, type of the metal and its filling factor. Because of the plasmonic absorption and the interference in the stacks, the present plasmonic metamaterials could act as a plasmonic rainbow where the different color can be realized. By replacing the metal-dielectric nanocomposite with a polymer-Spirophenanthrooxazine composite, the absorption of the system can be tuned dynamically. In other word, the absorption peak position and intensity can be changed upon illumination by UV or visible light which demonstrate a robust and fast-responding photoswitchable perfect absorber for visible frequency.

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