Deposition time effect of photogrown and photodecorated Ag nanoparticles on ZnO nanocolumns for SERS substrates

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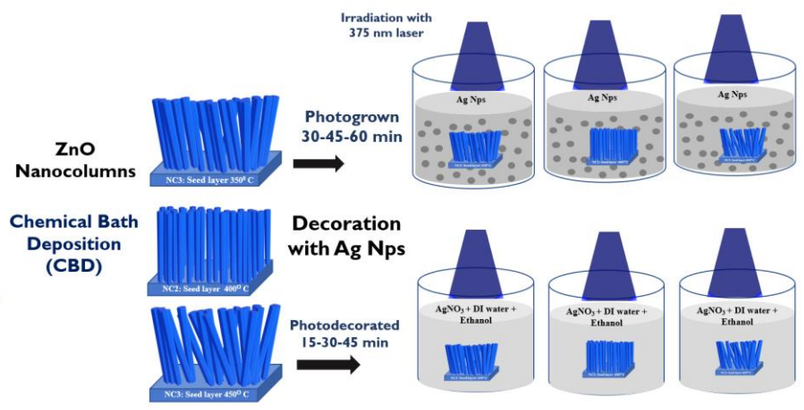
ABSTRACT

Silver nanoparticles were deposited on ZnO nanocolumns (Ag-NP@ZnO-NC) by two different laser-assisted approaches: photodecoration method were separately the Ag NPs are synthesized and then deposited over ZnO NCs under a laser-irradiated solution and photogrowthing method which the Ag NPs were simultaneously photoreduced and photodeposited over the ZnO NCs. The size and density of AgNPs were affected by the irradiation time ranged between 15 and 60 min. The Ag-NP@ZnO-NC substrates were evaluated by Surface-Enhanced Raman spectroscopy measurements of Rhodamine 6G (R6G) detection. SERS intensity increases as the deposition time increases for photodecorated devices and for photogrown substrates a contrasting behavior was observed. Substrates manufactured by photogrowthing method were found as the best SERS substrates with a 5-fold times signal enhancement compared with devices obtained by photodecoration and a limit of detection of 10^{-7} M for Rhodamine 6G is found. Finally, the cleaning of the substrate is carried out by means of UV radiation and it was found that with an approximate time of 90 min of radiation, the substrates can be reused.

METHODOLOGY



RESULTS

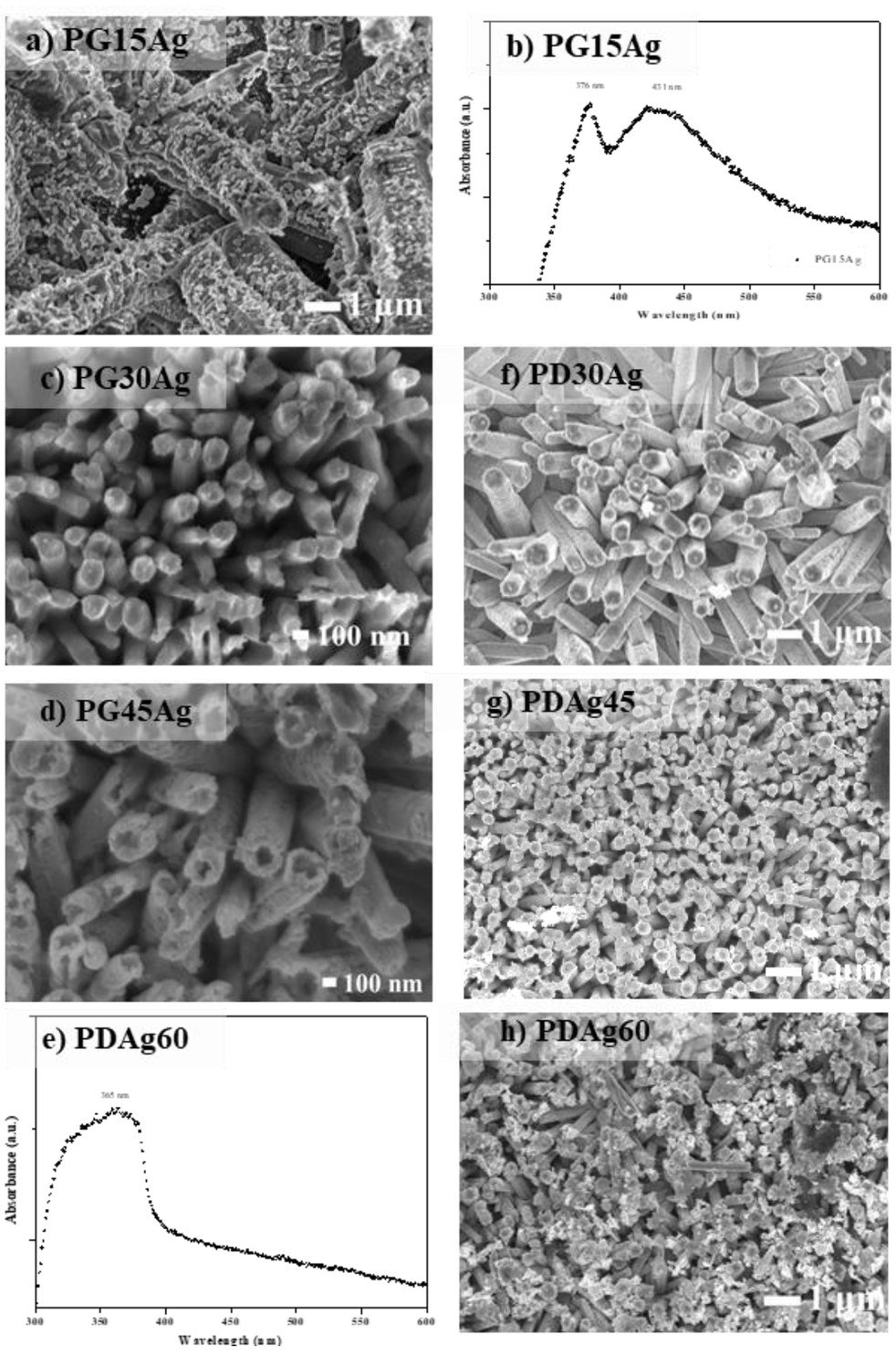


Figure 1. SEM images of photogrown (a,c,d) and photodecorated (f, g,h) Ag-NP@ZnO-NC substrates. Absorbance spectra of PG15Ag (b) and PD60Ag (e) samples.

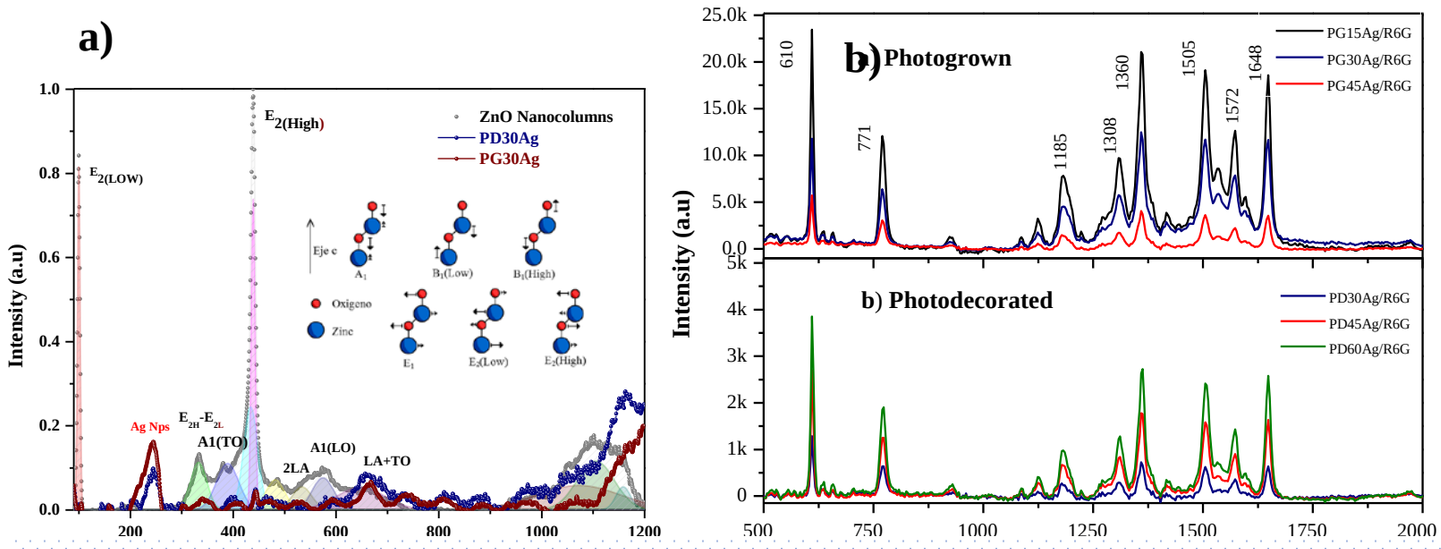


Figure 2. a) Raman spectra of ZnO NCs and Ag-NP@ZnO-NC substrates photodecorated (PD30Ag) and photogrown (PG30Ag) during 30 min, b) Raman spectra of 10^{-3} M R6G in Ag-NP@ZnO-NC substrates photodecorated and photogrown deposition.

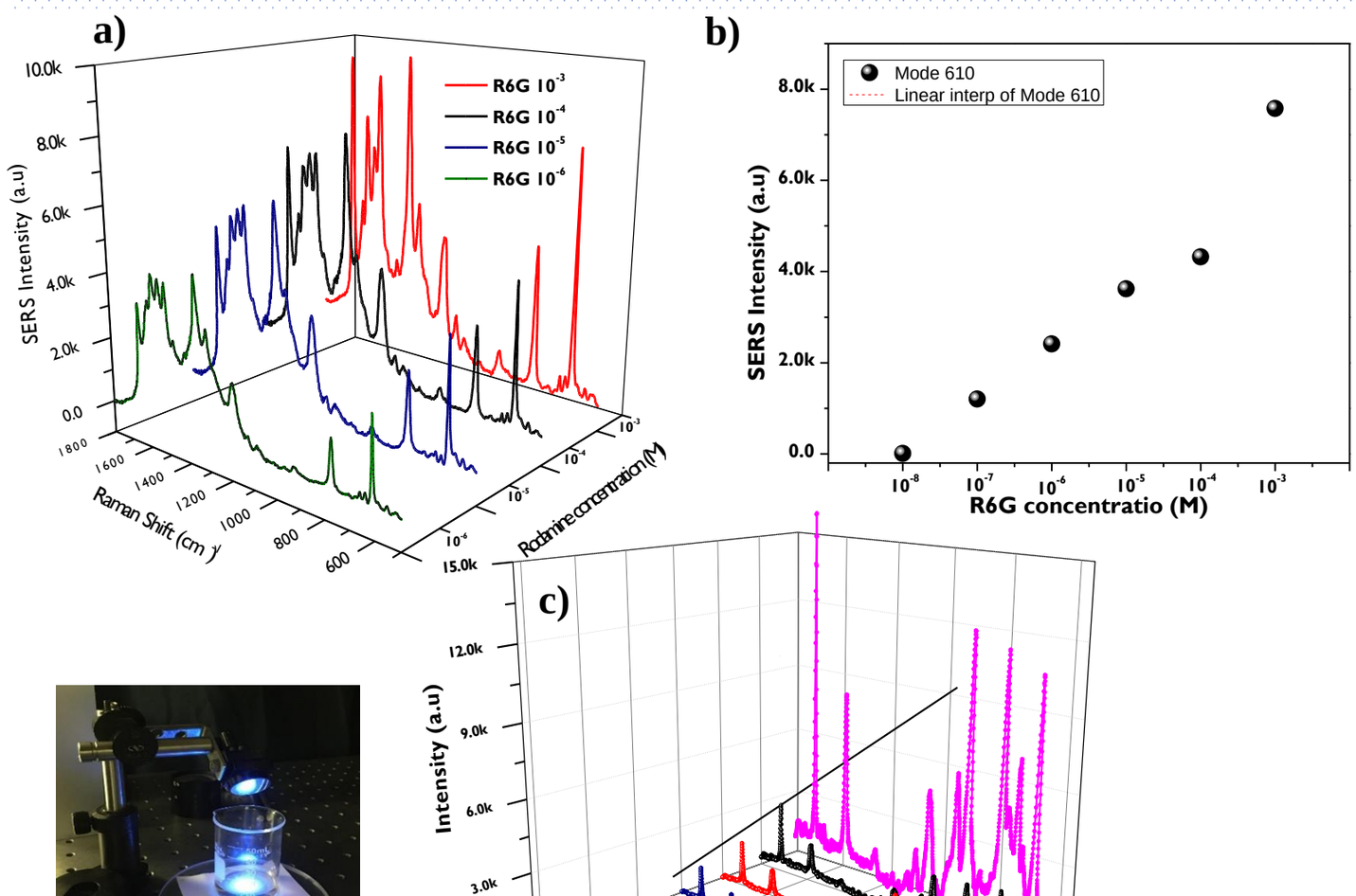


Figure 3. a) Raman spectra of the SERS PG30Ag/R6G substrate at different R6G concentrations b) SERS intensity of the 610 mode at different R6G concentrations c) Cleaning of the substrate by UV irradiation at different times.

CONCLUSIONS:

In this work, Ag-NP@ZnO-NC based SERS substrates were successfully fabricated using photodecoration and photogrowthing methodologies to deposit Ag nanoparticles on ZnO nanocolumnas. The photogrown method obtained a SERS intensity of 5 times more than the photodecorated, concentrations were measured around 10^{-7} M and substrate cleaning times of 90 minutes were obtained.