Aerosol-assisted processing of Dopamine-TiO_2 colloidal solution

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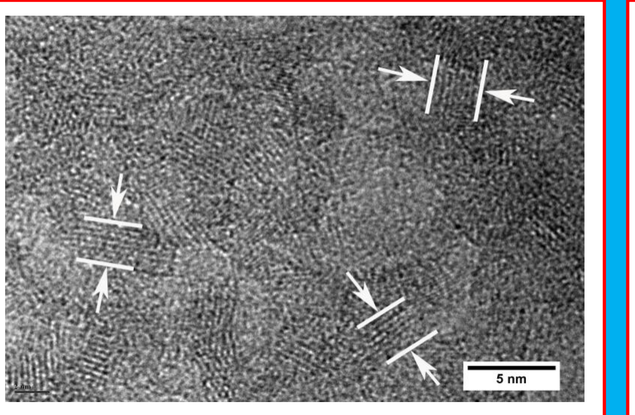
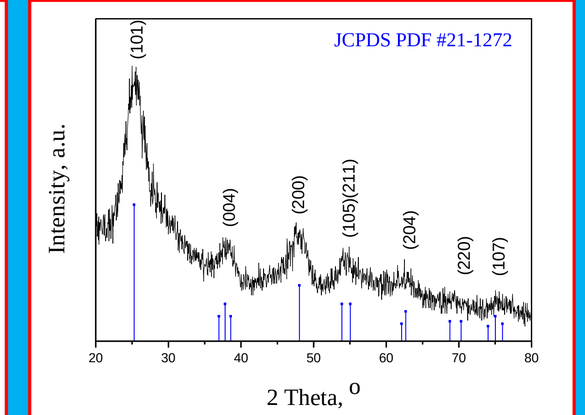
INTRODUCTION

Colloidal TiO_2 nanoparticles solution (TiO_2 NPs) was surface modified with dopamine (DA) in order to change its optical properties. Dopamine modified TiO_2 NPs solution (DA-TiO_2 NPS) was used as a precursor for the synthesis of DA modified submicronic TiO_2 particles for visible light absorption (DA-TiO_2 SPs).

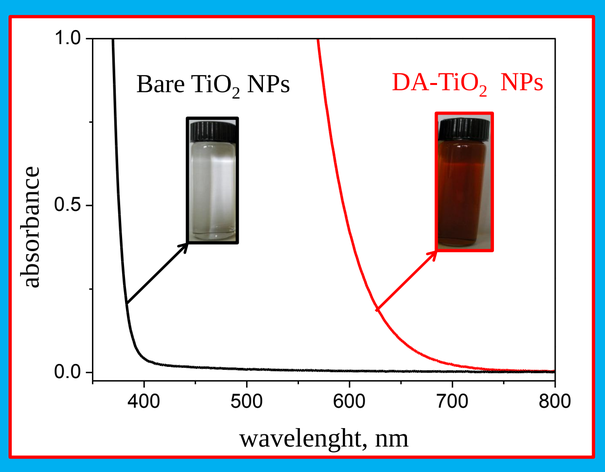
Colloidal TiO_2 NPs solution (d_p~4.5 nm)
↓
Surface modification with Dopamine
↓
DA-TiO_2 NPs solutions
↓
Aerosol-assisted processing at low temperature (T=150 °C)
↓
DA-TiO_2 SPs for UV light absorption

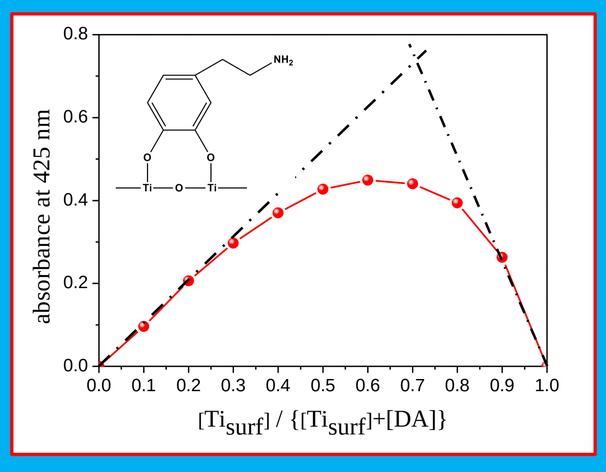
RESULTS AND DISCUSSION





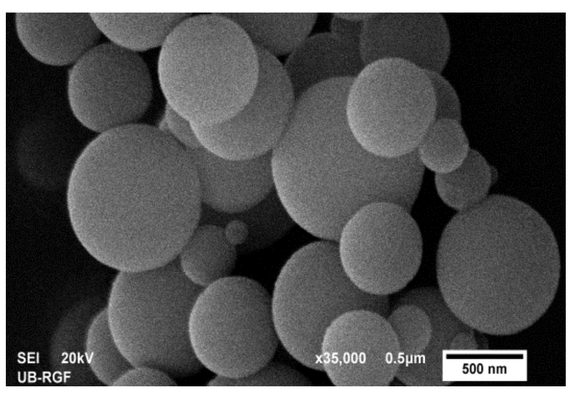
High magnification TEM image of TiO_2 NPs indicates that dry colloidal particles have nearly spherical shape with an average diameter of ~ 4.5 nm. Their XRPD analysis implicates that all diffraction peaks could be assigned to the anatase phase. Low crystallinity is noticeable from the XRPD reflections broadening.

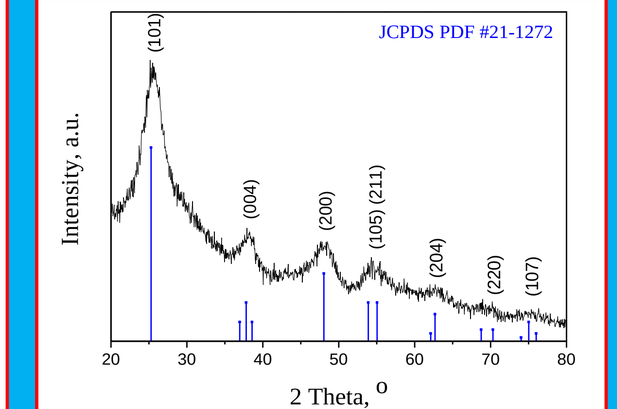




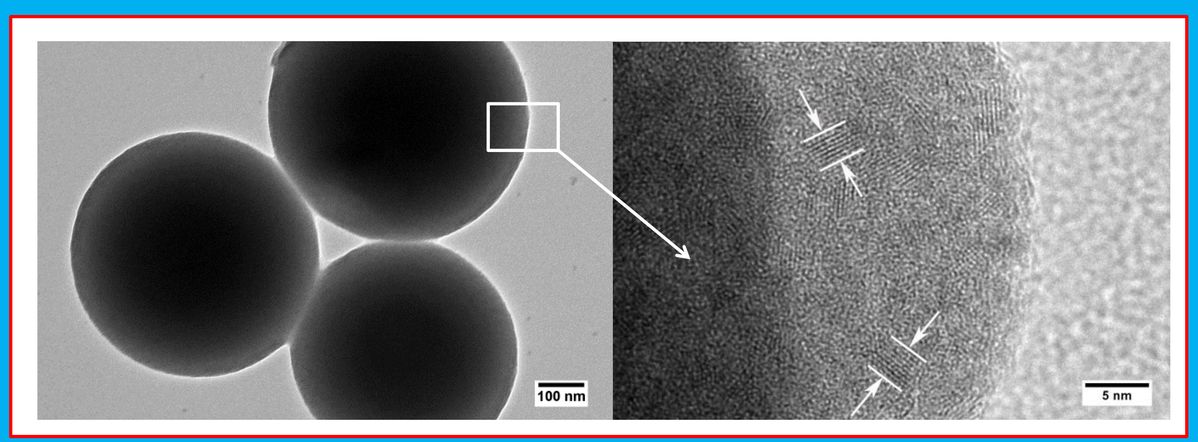
Absorption spectra of colloidal TiO_2 NPs and DA-TiO_2 NPs solutions used as precursors for synthesis of DA-TiO_2 SPs demonstrates red shift of ~1.3 eV indicating formation of the CT complex.

Job's method was applied in order to determine the stoichiometric composition of CT complex obtained as a result of Ti_{surf} atoms and DA complexation in DA-TiO_2 NPs solutions.

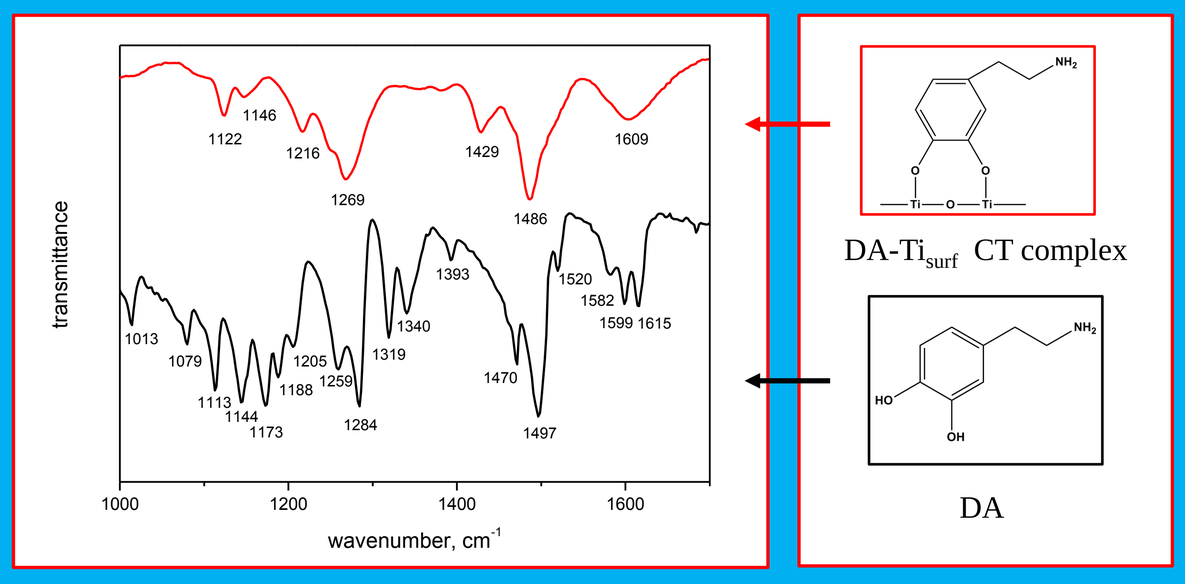




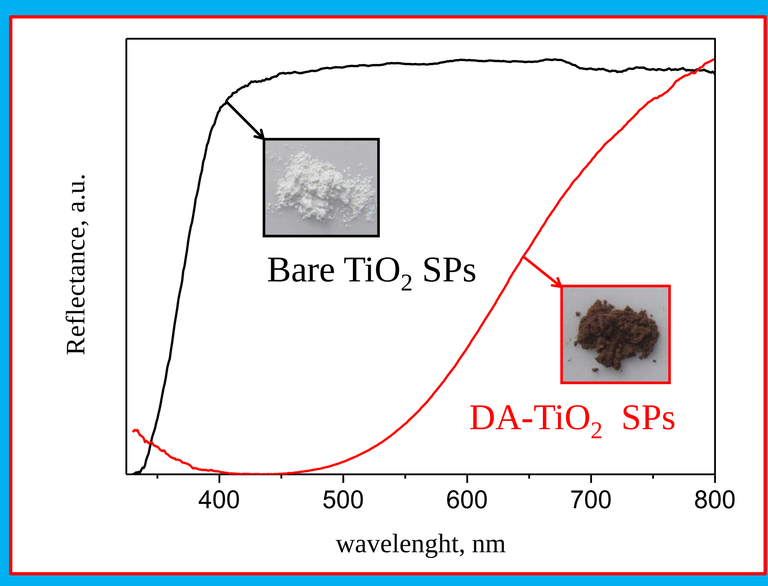
SEM image of DA-TiO_2 SPs shows that obtained particles are spherical in shape and non-agglomerated. Particle mean size is ~ 430 nm, and their composition stay unchanged, i.e. all XRPD reflections belongs to the anatase.

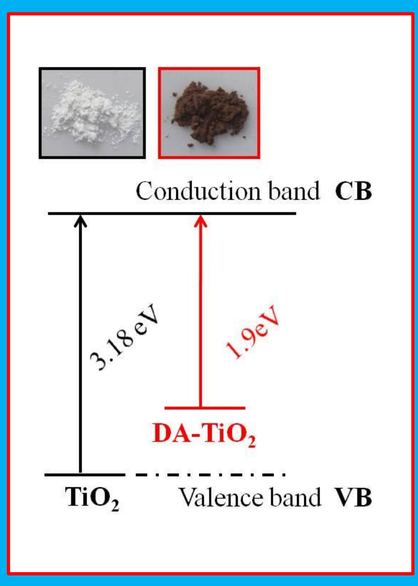


TEM image of the DA-TiO_2 SPs obtained through low temperature aerosol-assisted processing of DA-TiO_2 NPs confirms their spherical morphology.
High magnification TEM image exposes their polycrystalline nature and implies that the size of primary crystallites didn't change significantly in DA-TiO_2 SPs.



Presented FT-IR results related to the pure DA and DA-TiO_2 SPs agree well with the conclusion made from the Job's curve implicating that determined stoichiometric ratio (2:1) for the complexation of Ti_{surf} atoms and DA in DA-TiO_2 NPs stays unchanged in DA-TiO_2 SPs samples.





Bare TiO2 SPs sample has a sharp decrease of the reflection around ~385 nm corresponding to the fundamental band gap value of ~3.2 eV (typical for anatase crystal phase), while decrease of the reflection for DA-TiO_2 SPs is significantly shifted toward spectrum of visible light. The effective band gap value ~1.9 eV is estimated from the diffusive reflectance spectra revealing significant red shift of 1.3 eV for DA-TiO2 SPs .

CONCLUSION

Here, we present simple route toward to the obtaining of DA-TiO_2 based nano-structured submicronic particles which use low-energy photons in visible spectral region. It is shown that proposed synthesis strategy leads to the preservation of unique optical features of small colloidal TiO_2 particles.

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