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LASER CONTROL OF TiO_2-BASED NANOCOMPOSITES OPTICAL PROPERTIES

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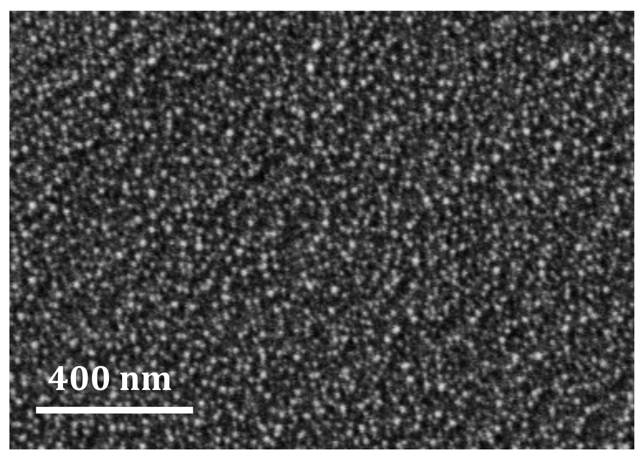
Aim and motivation

Laser processing of nanocomposite materials paves the way to local and precise control of their optical properties. However for concrete applications such as integrated optics, photonic devices, photocatalytic devices, and security labels it is critical to know the exact relationship between laser irradiation parameters and optical properties of the resulted material. This study is aimed at local control of spectral characteristics of TiO_2 based nanocomposite thin films with Ag nanoparticles (NP's) carried out by a 405 nm diode CW laser.

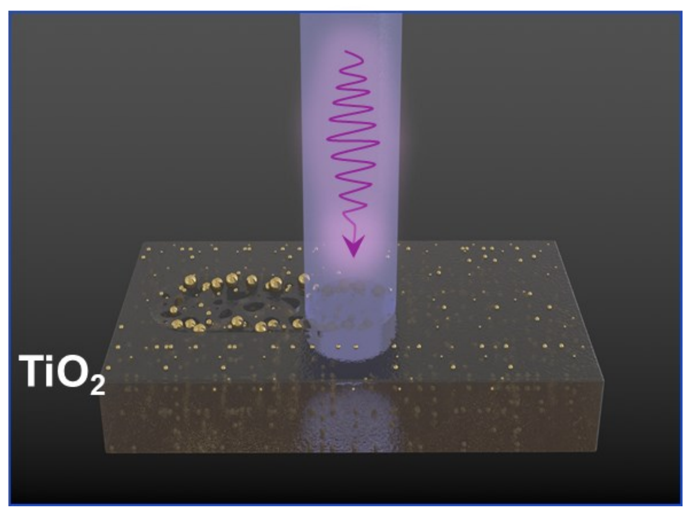


Initial film:

Porous TiO_2 sol-gel film on a glass substrate

h~180 nm, pore size ~ 5-7 nm

Containing Ag NPs < 10 nm



Laser treatment:

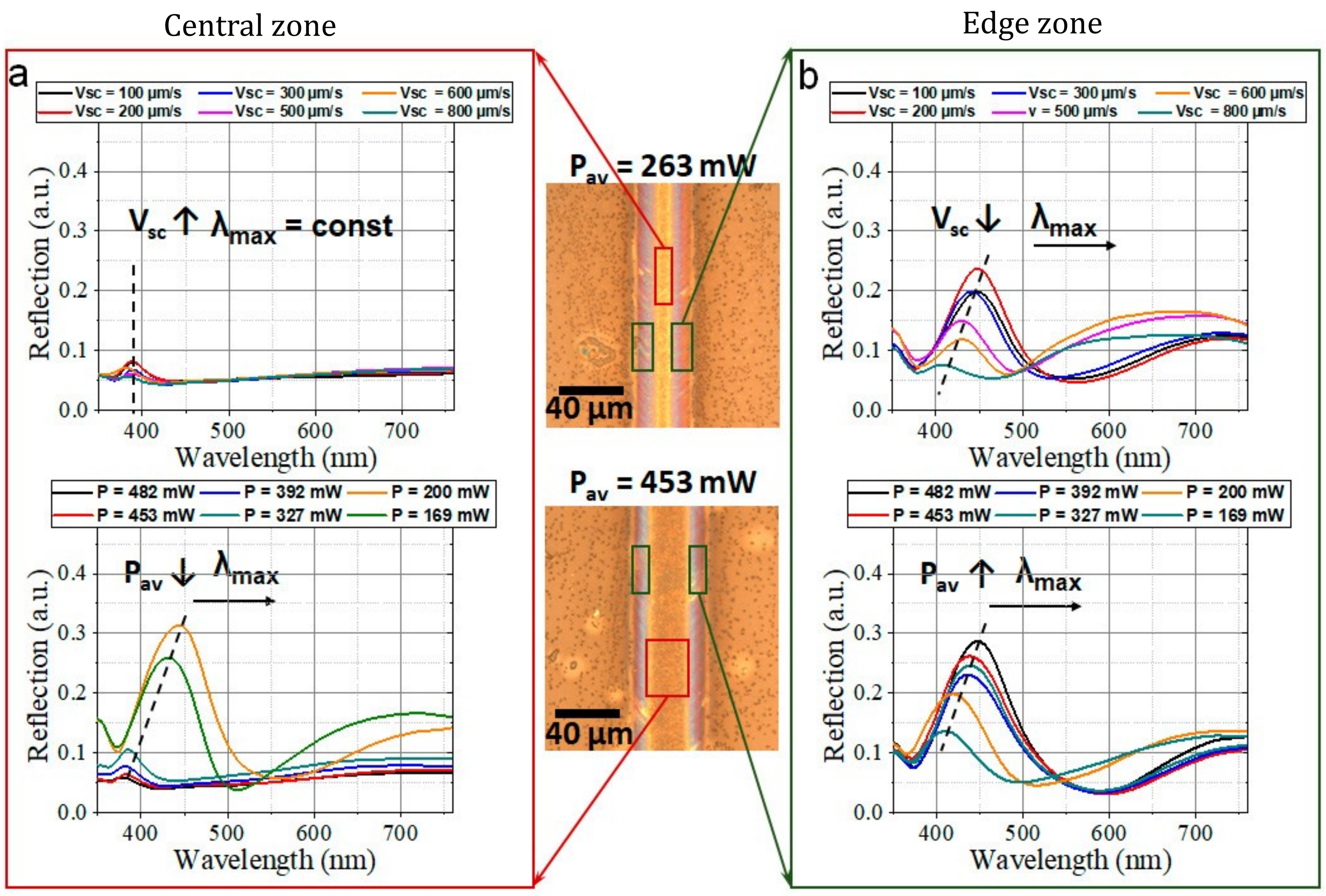
CW 405 nm diode laser

P_{av}=42-726 mW

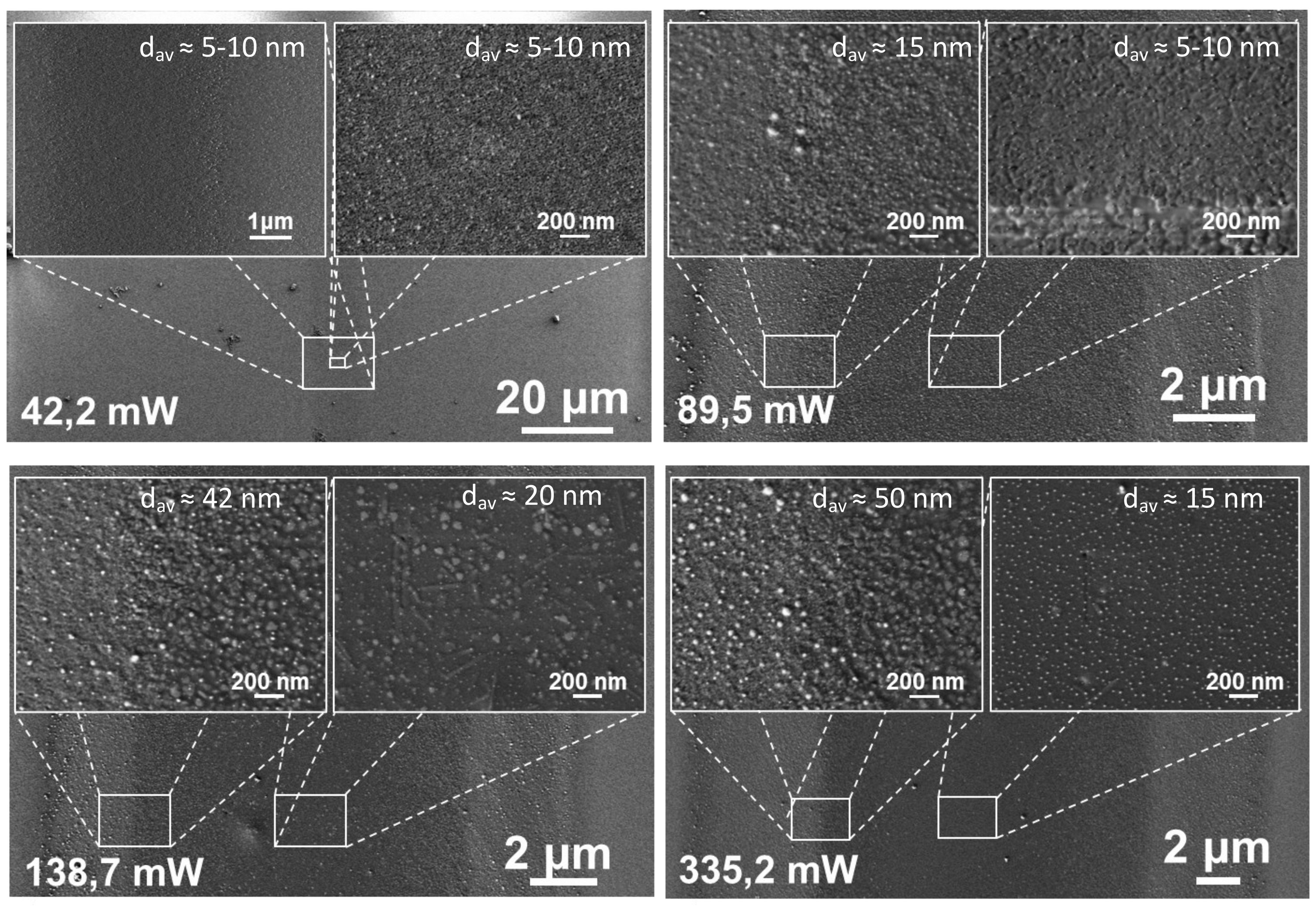
V_{sc}=0.10-0.8 mm/s

$d_0 \approx 20\mu m$

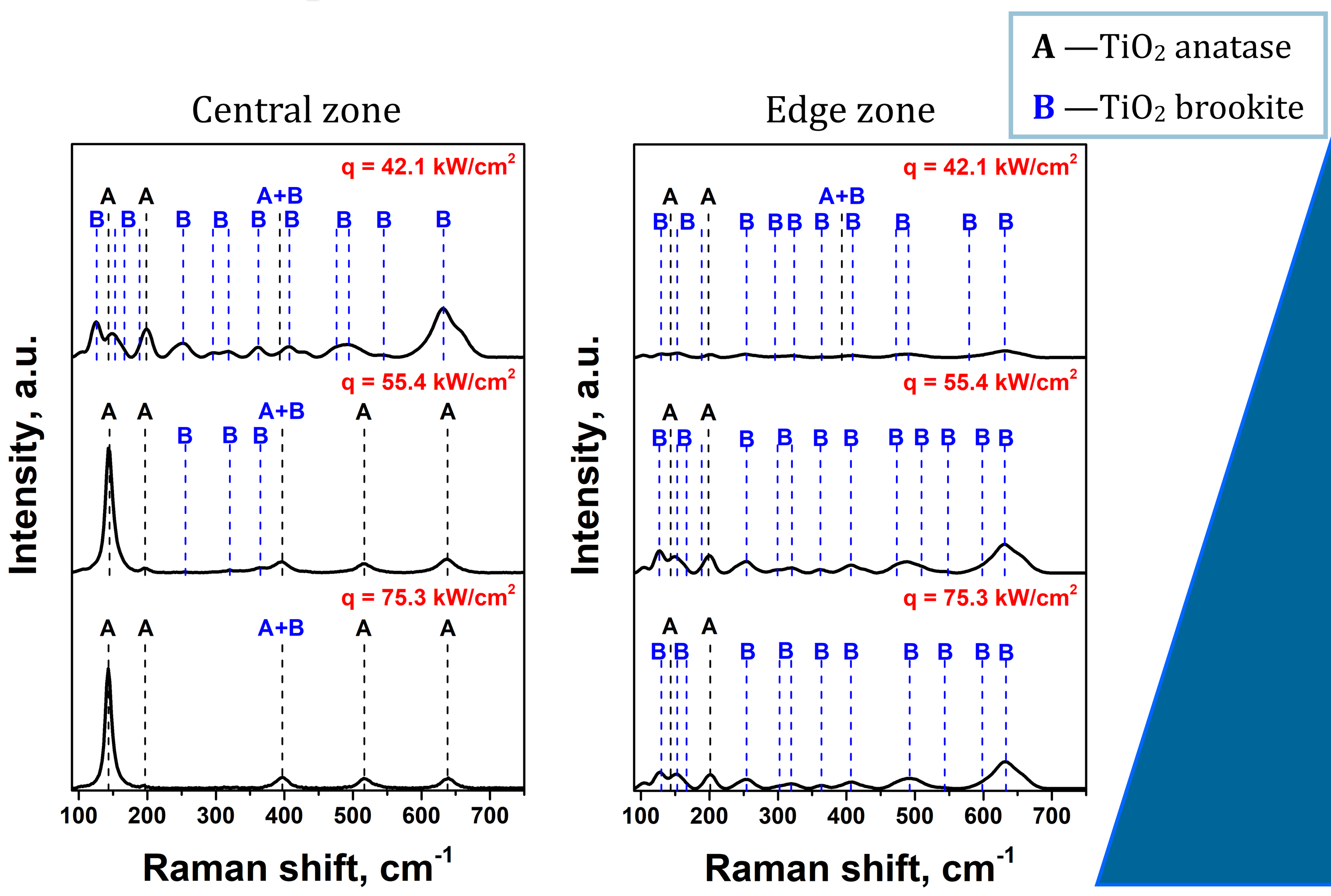
Spectral shifts



A decrease of the scan speed, as well as an increase of the intensity, lead to a red-shift of reflection maxima at the edges of the track as a result of the mean particles' size increase and wider size dispersion. On the other hand, in the center of the track, a change in the reflection spectra occurs only at the laser average power below 330 mW, where an increase in power leads to a shift of the reflection maximum to the blue region, which indicates a decrease in the mean size of NP's and a narrowing of their distribution. At an average power above 335 mW, there is no change in the size and dispersion of NP's in the center of the track.



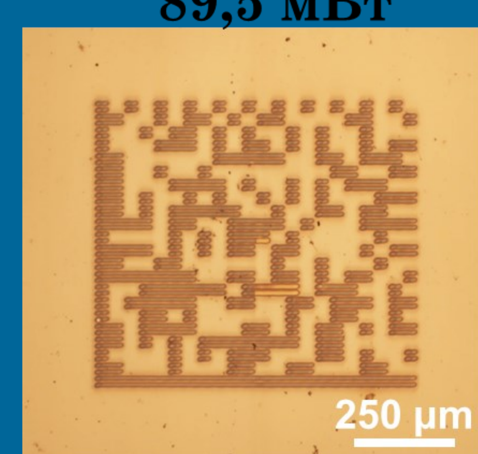
Raman spectra before and after laser treatment



Conclusions

According to our experimental observations the mean size of Ag NP's and their size distribution differ within the laser track. This leads to the spectral shifts of the material. The observed modifications are caused by inhomogeneous temperature distribution during laser heating that was proven by varied crystal phase of titanium dioxide. Such nanocomposite material and observed spectral dependencies can be useful for creation of microoptical elements, photonics devices as well as recording of hidden images and holograms for security.

89,5 мВт



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