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GAS SENSORS BASED ON PLD-MODIFIED GRAPHENE FOR ENVIRONMENTAL MONITORING

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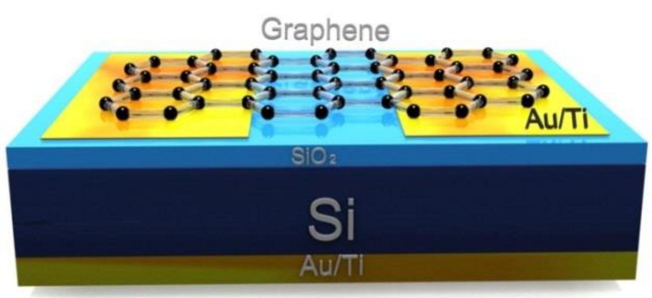
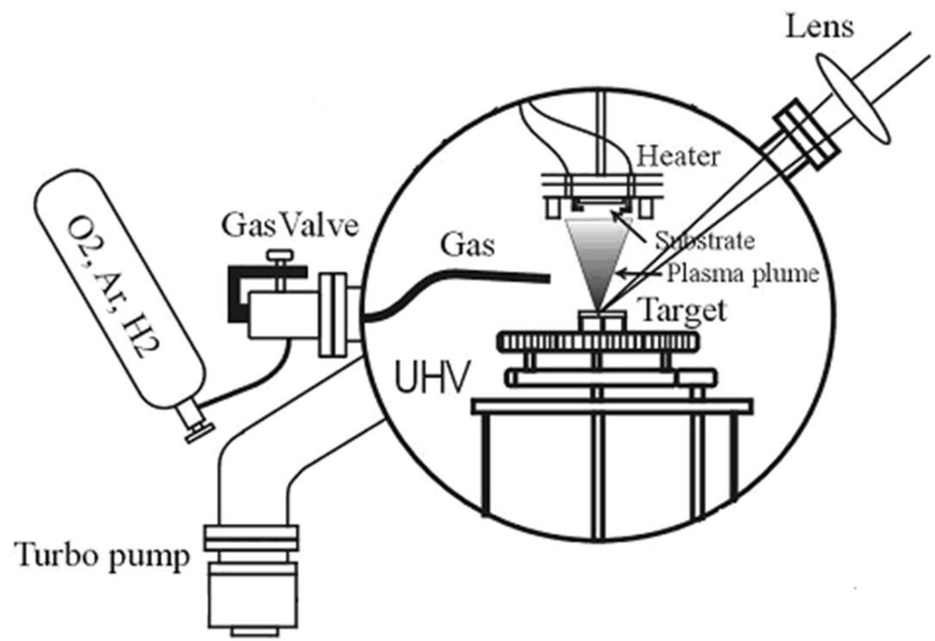
Motivation

- High potential of graphene – responses to single gas molecules have been demonstrated
- For fully exploiting the potential of graphene new approaches are required for not only increasing the sensitivity but also making the devices (partially) selective
- In addition, for practical use, stability and response/recovery time of such sensors have to be improved
- **In the present work, we demonstrate the functionalization of single layer graphene by pulsed laser deposition (PLD) and its impact on the sensing properties to NO_2 gas in case of different deposited materials**

Experiment

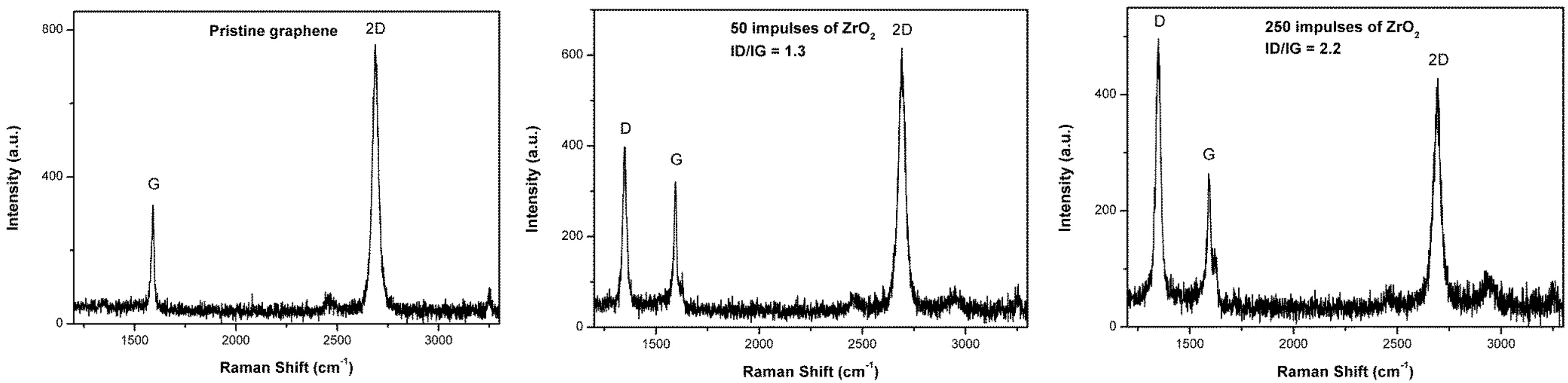
- Sensor structures: lab-grown CVD graphene, transferred onto Si/SiO_2 substrates pre-patterned with Ti/Au electrodes
- Functionalization by PLD process using different deposition targets (ZrO_2, TiN, and Ag) ablated by KrF excimer laser. The process was carried out in oxygen or nitrogen gas at $5x10^{-2}$ mbar.
- ~1/100th of a monolayer is typically deposited by a single laser pulse





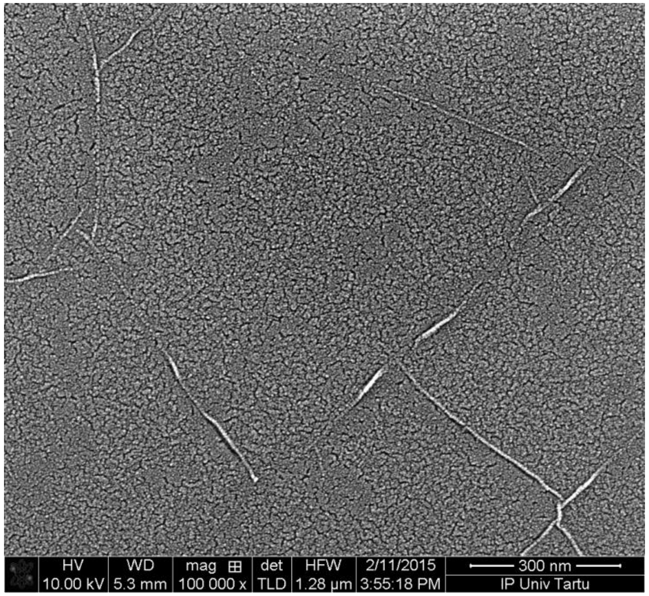
Results: Raman

- Appearance of defect-related D band in Raman spectra after PLD process
- Decreasing of 2D band, which characterizes crystalline quality of graphene

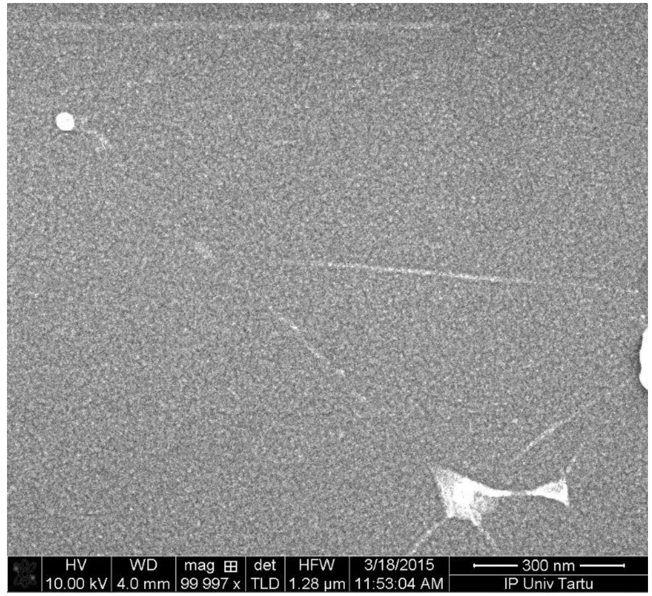


Results: SEM

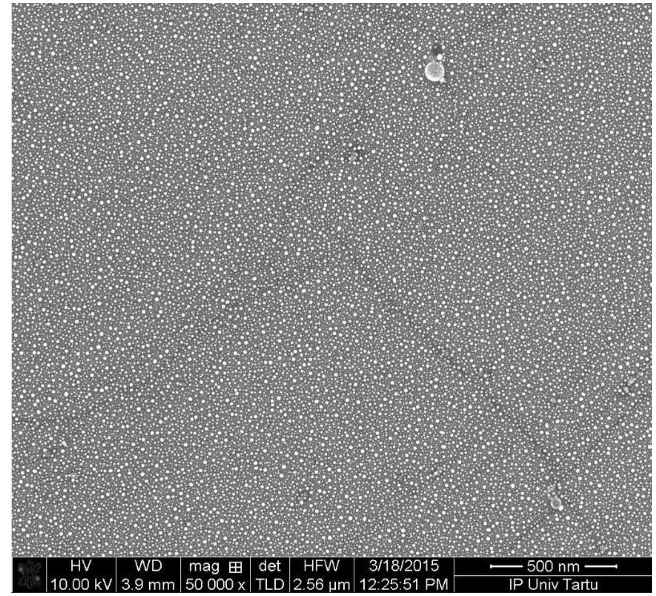
ZrO_2 – 1000 pulses



TiN – 675 pulses



Ag – 720 pulses

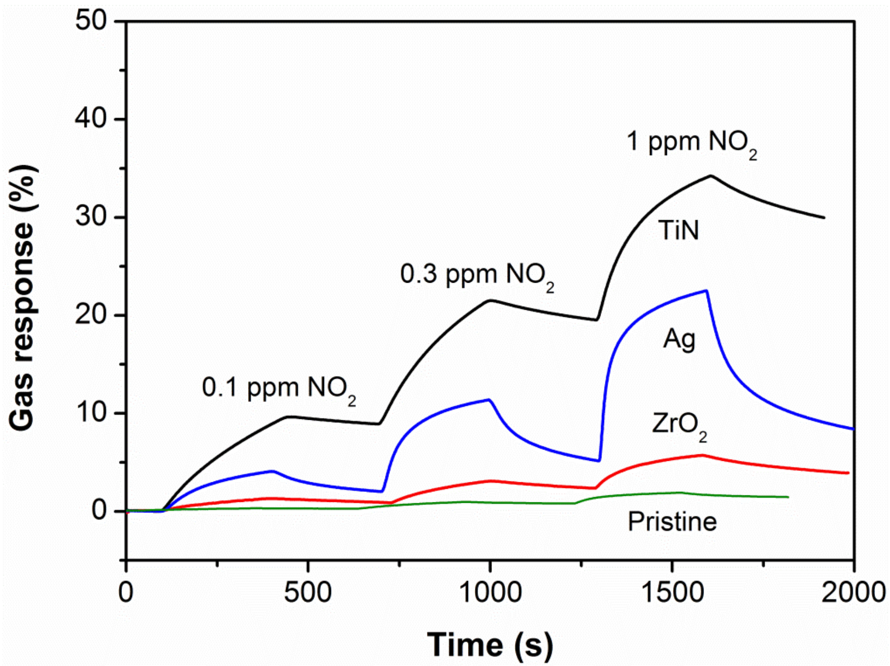


From data of Raman and SEM – nanostructured PLD grown material on defective single layer graphene

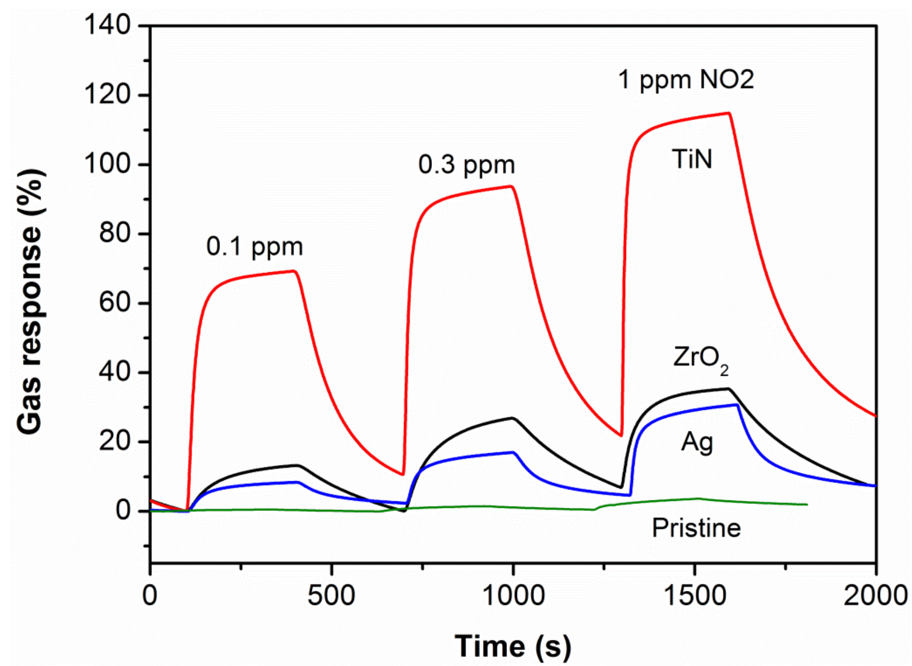
Results

Responses to NO_2 measured at room temperature

No UV illumination



365 nm UV illumination



CONCLUSIONS

- This method can be used for creating different types of functionalized graphene based sensing films by using different target materials and deposition conditions
- New sensor structures can expectedly be created for the fast responding, sensitive and (partially) selective detection of other gases as well
- Estimated limit of detection **below 1 ppb**
- Open problems:
  - Long term stability and repeatability has to be tested
  - Influence of varying humidity level has to be tested

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