Interaction of benzene and toluene vapors with Ru(0001) surface

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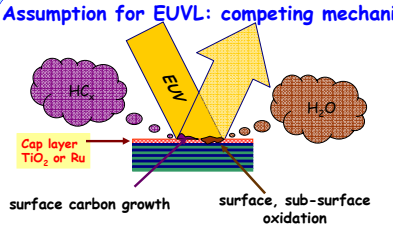
Assumption for EUVL: competing mechanisms



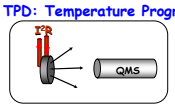
Our results: deposition of C on Ru from benzene and toluene vapor under electron irradiation

Goals

- Characterize thermal-induced interaction of benzene and toluene with Ru(0001)
- To probe interaction of HC with graphene-coated Ru(0001)
- Characterize carbon accumulation on Ru and C/Ru upon el. irradiation in the presence of HC vapor

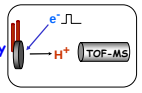
Methods

TPD: Temperature Programmed Desorption

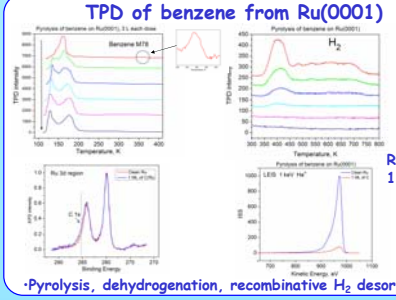


*clean surface
*dose gas (benzene, toluene)
*heat at linear rate
*determine energies, lifetimes

ESD: Electron stimulated desorption and reaction
XPS: X-ray photoelectron spectroscopy
LEIS: Low energy ion scattering
STM: Scanning tunneling microscopy
LEED: Low energy electron diffraction



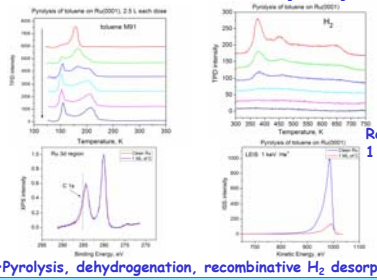
TPD of benzene from Ru(0001)



Result: 1 ML C

·Pyrolysis, dehydrogenation, recombinative H_2 desorption

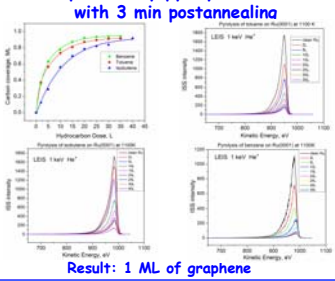
TPD of toluene from Ru(0001)



Result: 1 ML C

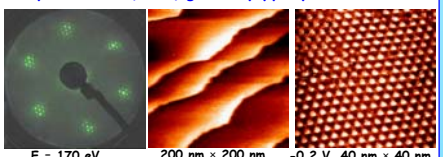
·Pyrolysis, dehydrogenation, recombinative H_2 desorption

Graphene deposition by pyrolysis of HC at 1100 K with 3 min postannealing



Result: 1 ML of graphene

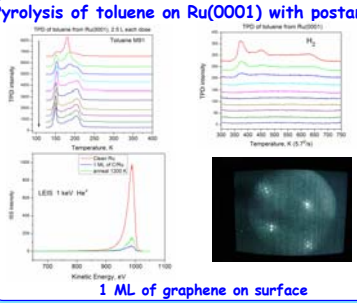
Graphene on Ru(0001) grown by pyrolysis of benzene



E = 170 eV | 200 nm × 200 nm | -0.2 V 40 nm × 40 nm

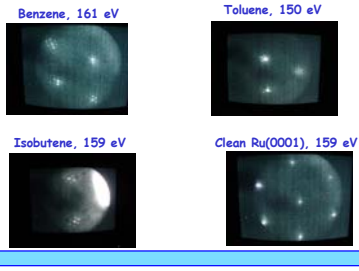
·Deposition of 30 L benzene at 1100 K followed by flashing to 1200 K
·Atomically flat graphene ML is prepared
·Hexagonal Moire pattern is observed

Pyrolysis of toluene on Ru(0001) with postannealing

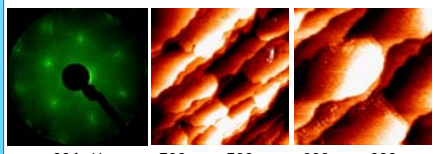


1 ML of graphene on surface

Result of HC pyrolysis at 1100 K with 3 min postannealing



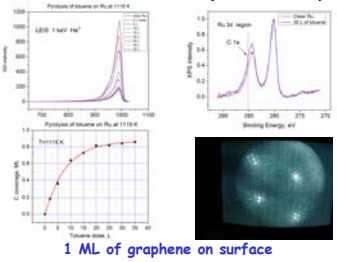
Graphene Bilayer grown by C segregation at 1000 K



284 eV | 500 nm × 500 nm | 200 nm × 200 nm

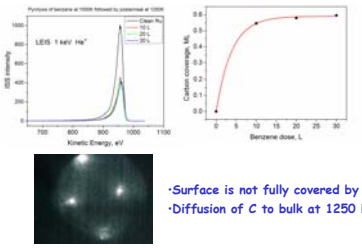
Bilayer graphene grows on terraces

Graphene deposition on Ru(0001) by pyrolysis of toluene at 1115 K *(Martoccia et al)*



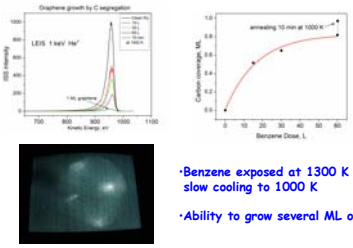
1 ML of graphene on surface

Graphene deposition by pyrolysis of benzene at 1000 K with postannealing at 1250 K



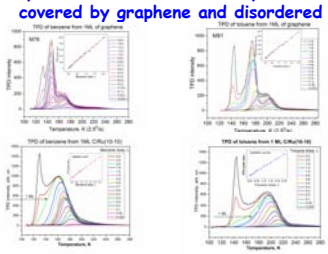
·Surface is not fully covered by graphene
·Diffusion of C to bulk at 1250 K

Graphene deposition on Ru(0001) by segregation of C *(Sutter)*



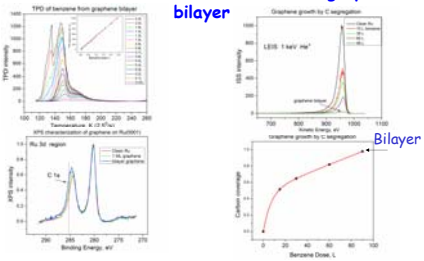
·Benzene exposed at 1300 K followed by slow cooling to 1000 K
·Ability to grow several ML of graphene

Comparison of HC thermodesorption from Ru covered by graphene and disordered C



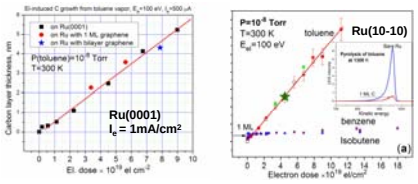
E(ads) on graphene is lower

TPD of benzene from Ru covered with graphene bilayer



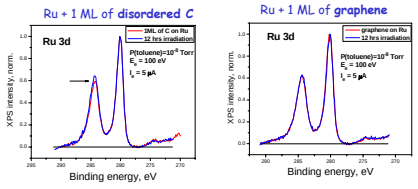
Bilayer is grown by C segregation

Carbon growth on Ru under electron irradiation



·Molecular impingement rate is rate – determining at intense electron irradiation

Carbon growth on Ru under electron irradiation in the presence of toluene vapor at low current density



I_e = 10 μA/cm²

·Effect of graphene is clearly seen at low irradiation level

Summary

·Thermal-induced reaction of Ru with HC leads dehydrogenation and 1ML carbon film formation

·El. irradiation in the presence of HC vapor leads to carbon accumulation on Ru(0001)

·Radiation-induced C accumulation on Ru(0001) is lower on graphene coated surface than on 1 ML of disordered C

·Binding energy of HC on graphene-coated Ru is lower than on disordered carbon-coated Ru

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