Task 5 description

Task 5: Broader accelerator and societal applications
(M. Tomut – GSI)

This task will follow broader applications of new developed materials for high-power accelerators, space, society (energy, medicine, computing)

- Irradiation induced defect centers in diamond for luminescent screens, medical imaging and quantum computing.
- Application of novel materials for high power targets, beam catchers, beam windows.
- Applications for advanced engineering solutions, efficient energy solutions, space.
- Applications for thermal management.

Participants: CERN, GSI, Brevetti Bizz, RHP Technology

Milestone

Task 17.5) Report on studies, with publication of report on web, [month 46]

NV- color center induced by SHI irradiation in N implanted diamond

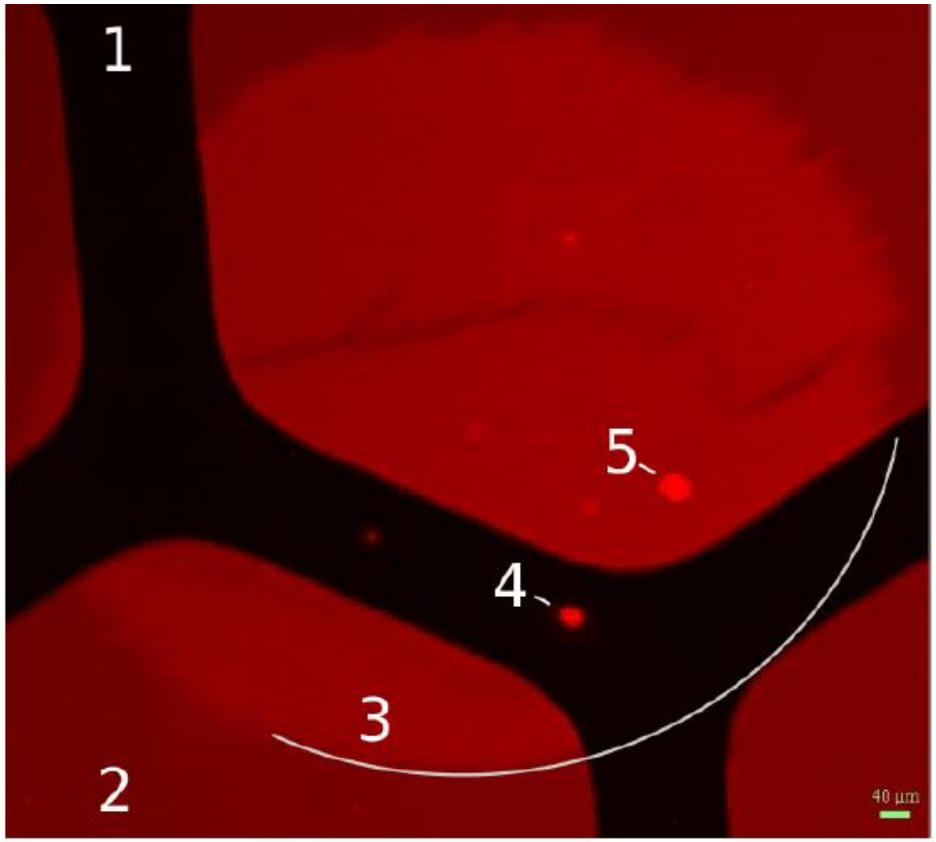
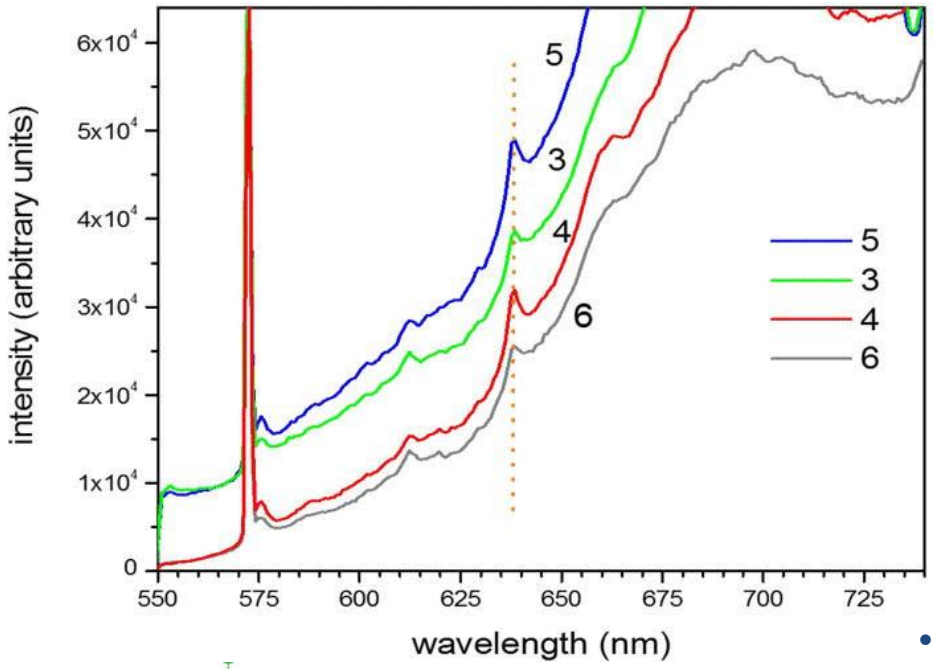
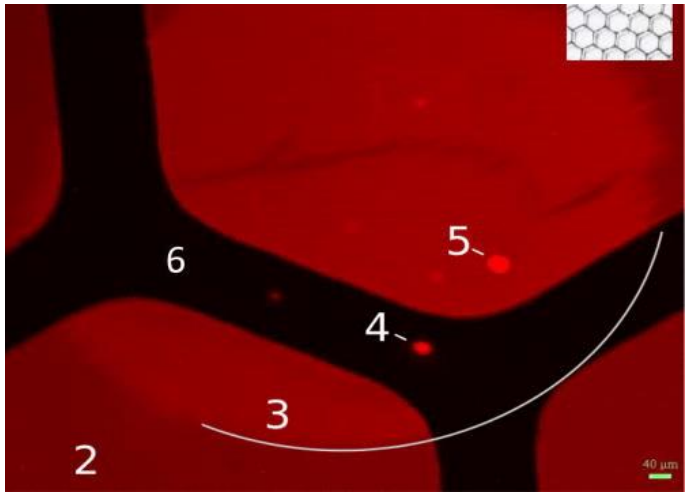


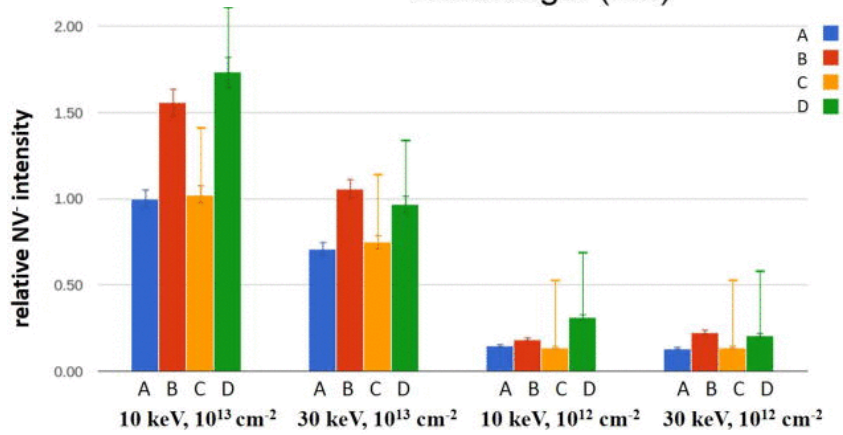
Figure 1: Hyperspectral image (635-642 nm) over an 3.5 mm² area showing the photoluminescent intensity from 1) pristine diamond, 2) radiation damage induced by swift heavy ions, 3) the circular Nitrogen implant spot with NV centers activated by swift heavy ions, 4) NV center activated by low energy electrons using a SEM, 5) NV center activated by a combination of first swift heavy ions followed by SEM irradiation. The swift heavy ions were masked by a honeycomb grid as is clearly seen and the spectra were taken before and after any (global) thermal annealing. The numbers correspond to the spectra shown in Figure 2.

Local NV-center formation by electronic excitation from swift, heavy ions – yields after thermal annealing





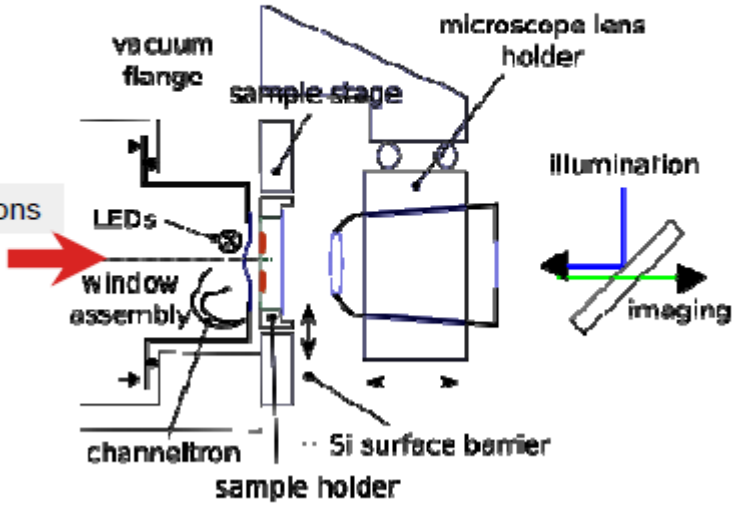
J. Schwartz, et al., J. Appl. Phys., 2014

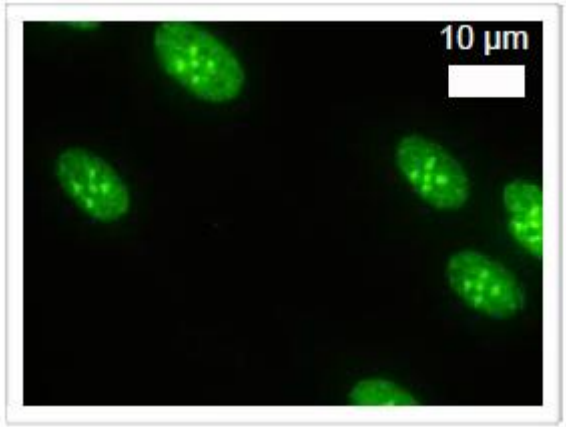


- NV yields higher by factor 1.7x for e-beam and then thermal annealing vs. thermal annealing alone (850 °C, 1 h, in vacuum)
- But no evidence for additive effect of swifts and thermal annealing
- Formation yield is ~0.1 of yield from high fluence e-beam and ~0.02 of yield from thermal annealing
- absolute NV/N ~ 10^{-4}–10^{-3}

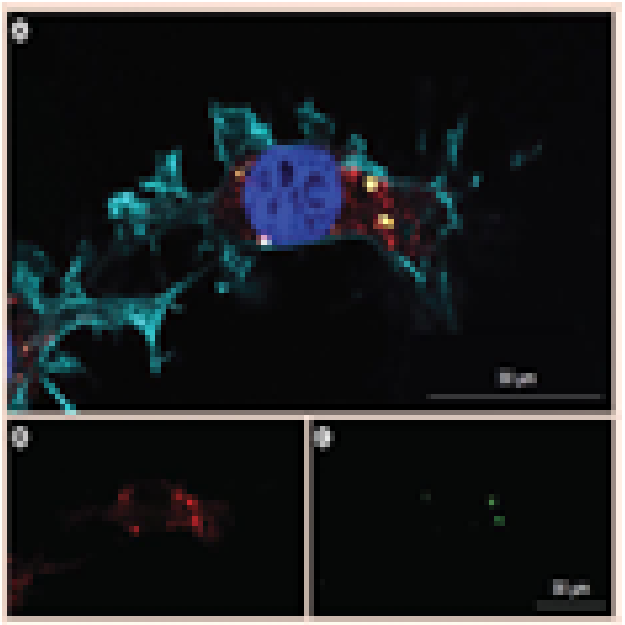
Biophysics and medical applications

Radiation effects in cells-
Ion beam microprobe





Functionalized nanodiamond particles for medical imaging



Outloook

WP 17. Materials for extreme thermal management (PowerMat)

1. Optimize metal matrix for better response to fast extracted heavy ion beams
2. Optimize diamond particle sizes and distribution for different applications
3. Optimize color centers in diamond for different applications (luminescence screens, QD's and medical imaging) - using different doping recipe
4. Explore the use of intense ion pulses for materials processing far from equilibrium