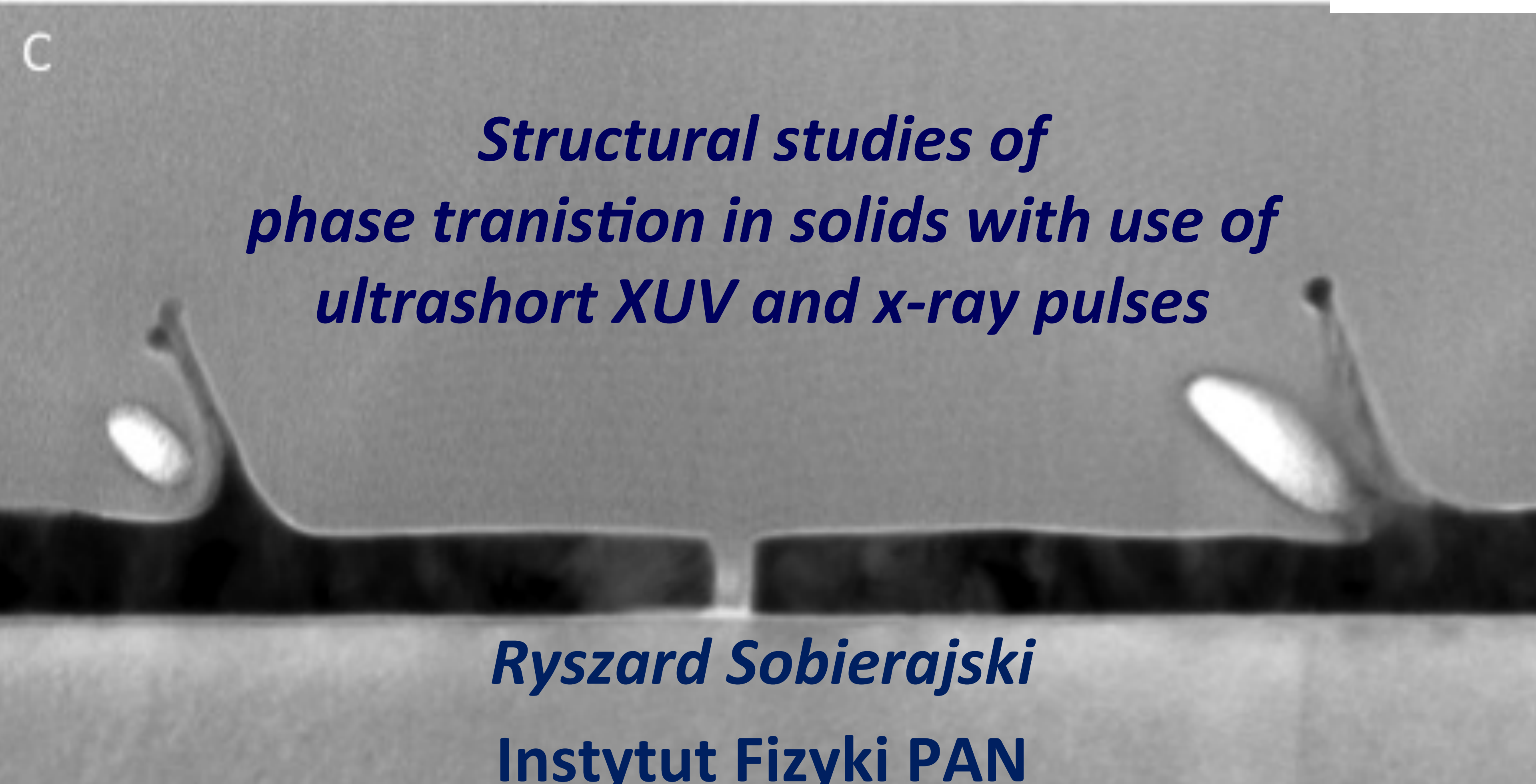
Structural studies of phase tranistion in solids with use of ultrashort XUV and x-ray pulses



Ryszard Sobierajski

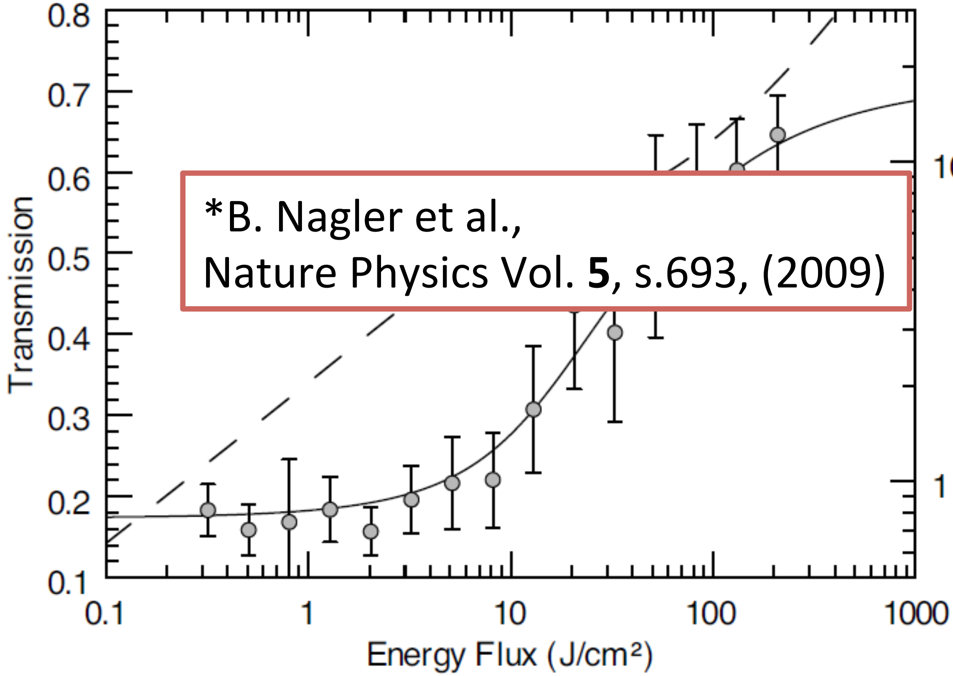
Instytut Fizyki PAN

What's interesting? – personal view

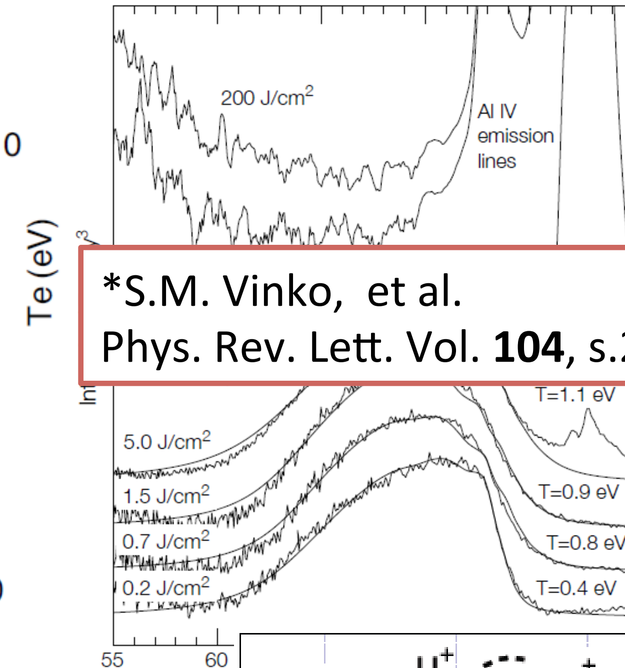
Unique XUV & X-FEL radiation properties	Why is it important?
High intensity	Allows to excite a solid material through phase transition points or probe it within a single shot
XUV / X-ray spectral range	Linear absorption in all materials for most of irradiation conditions
Short pulses	Absorption on a time scale shorter than most of the time constants related to structural transformations and to the energy transfer (>100 fs)

ELI as a complementary source for XFELs

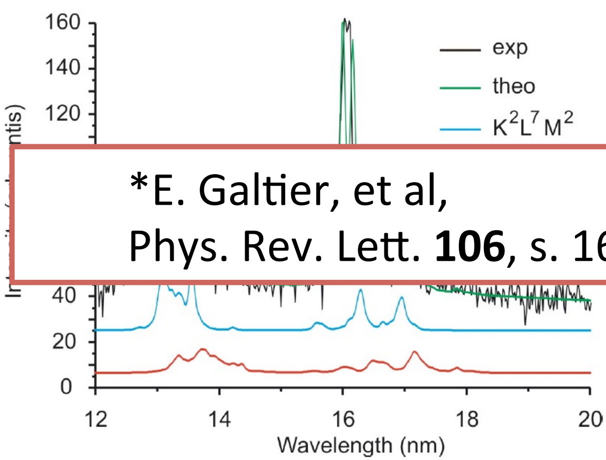
Saturated absorption in Al



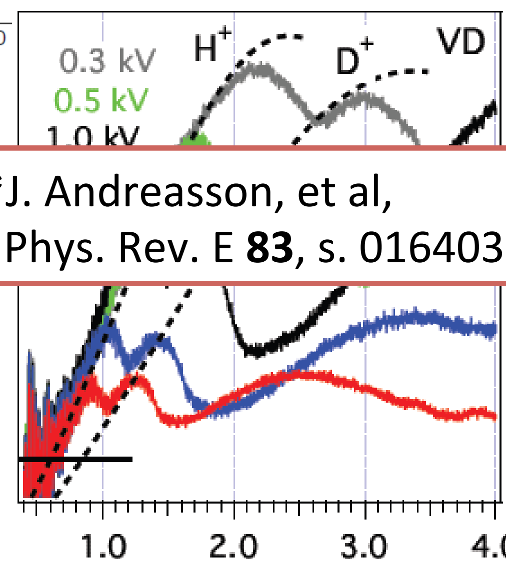
*B. Nagler et al.,
Nature Physics Vol. **5**, s.693, (2009)



*S.M. Vinko, et al.
Phys. Rev. Lett. Vol. **104**, s.225001 (2010)

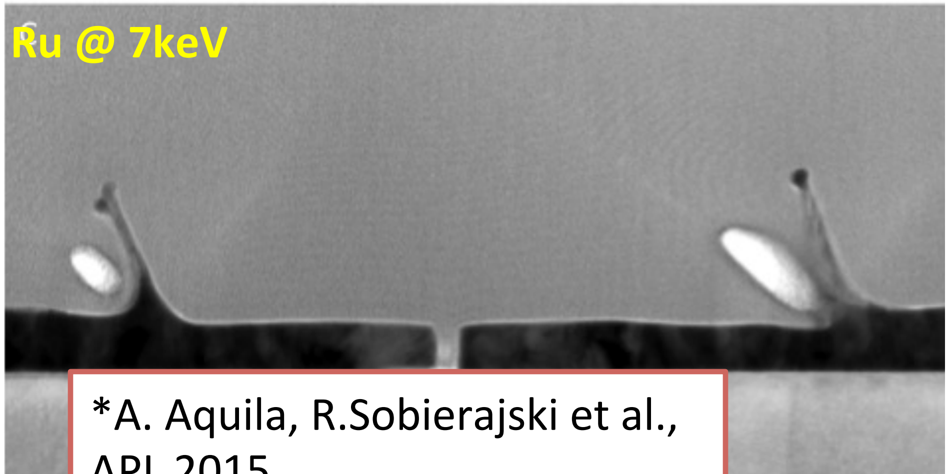


*E. Galtier, et al,
Phys. Rev. Lett. **106**, s. 164801 (2011)

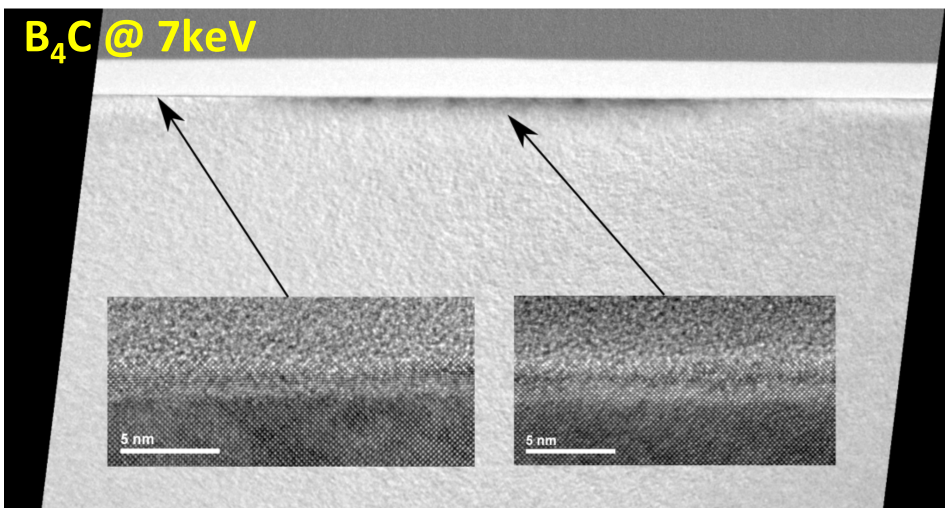


*J. Andreasson, et al,
Phys. Rev. E **83**, s. 016403 (2011)

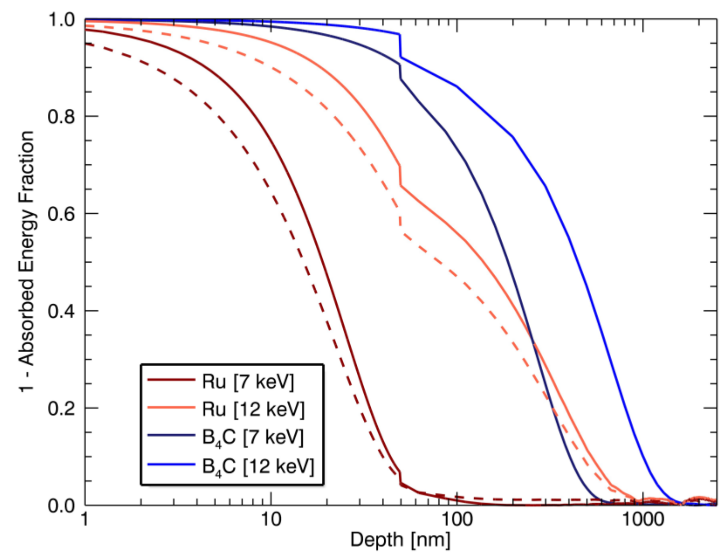
Energy transport by ballistic electrons



*A. Aquila, R.Sobierajski et al., APL 2015



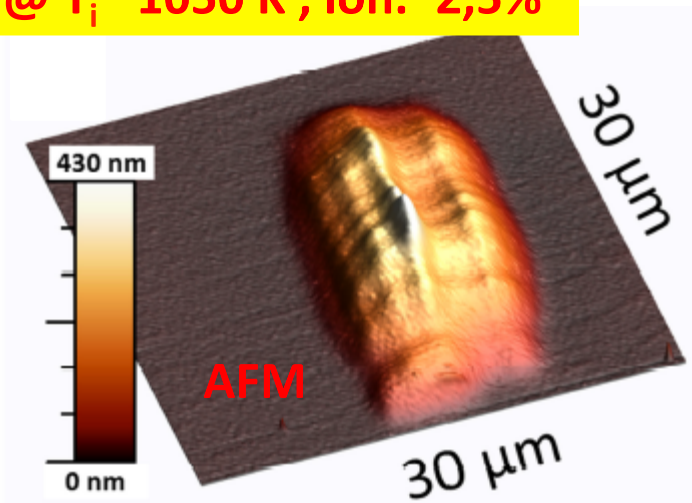
Damage threshold of Ru:
57 eV/atom @ 7keV
112 eV/atom @ 12keV

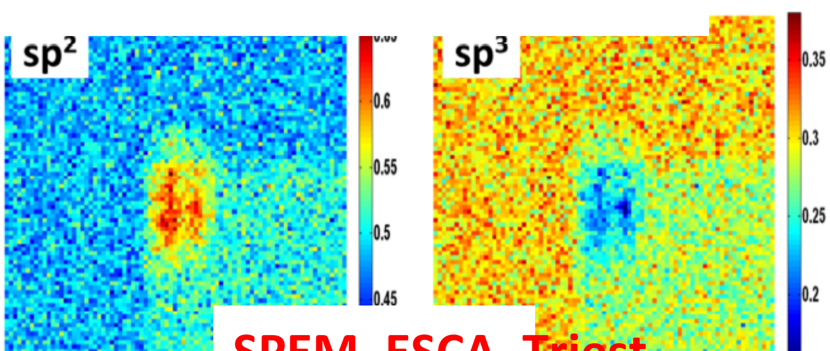


Damage threshold of B_4C:
~ 20 eV/atom @ 7keV
> 100 eV/atom @ 12keV

Phase transitions in solids (s-s & s-l)

Graphitisation a-C
@ T_i ~1050 K , ion.~2,5%

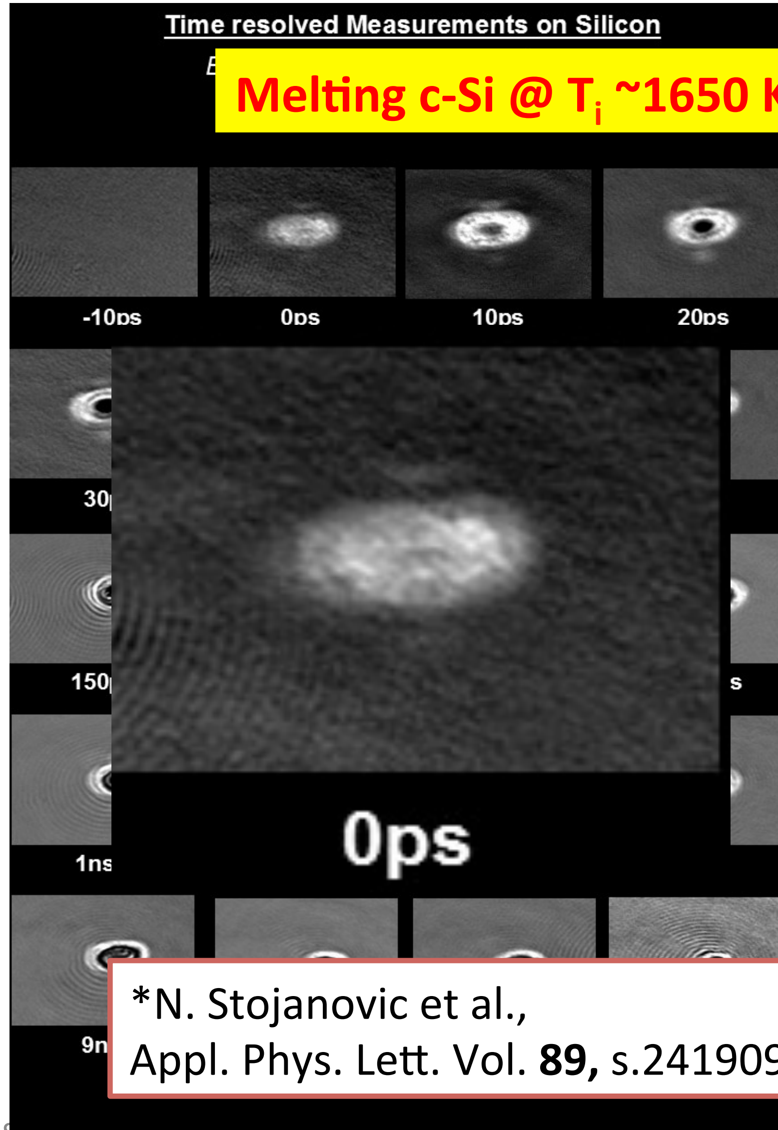




SPEM, ESCA, Triest

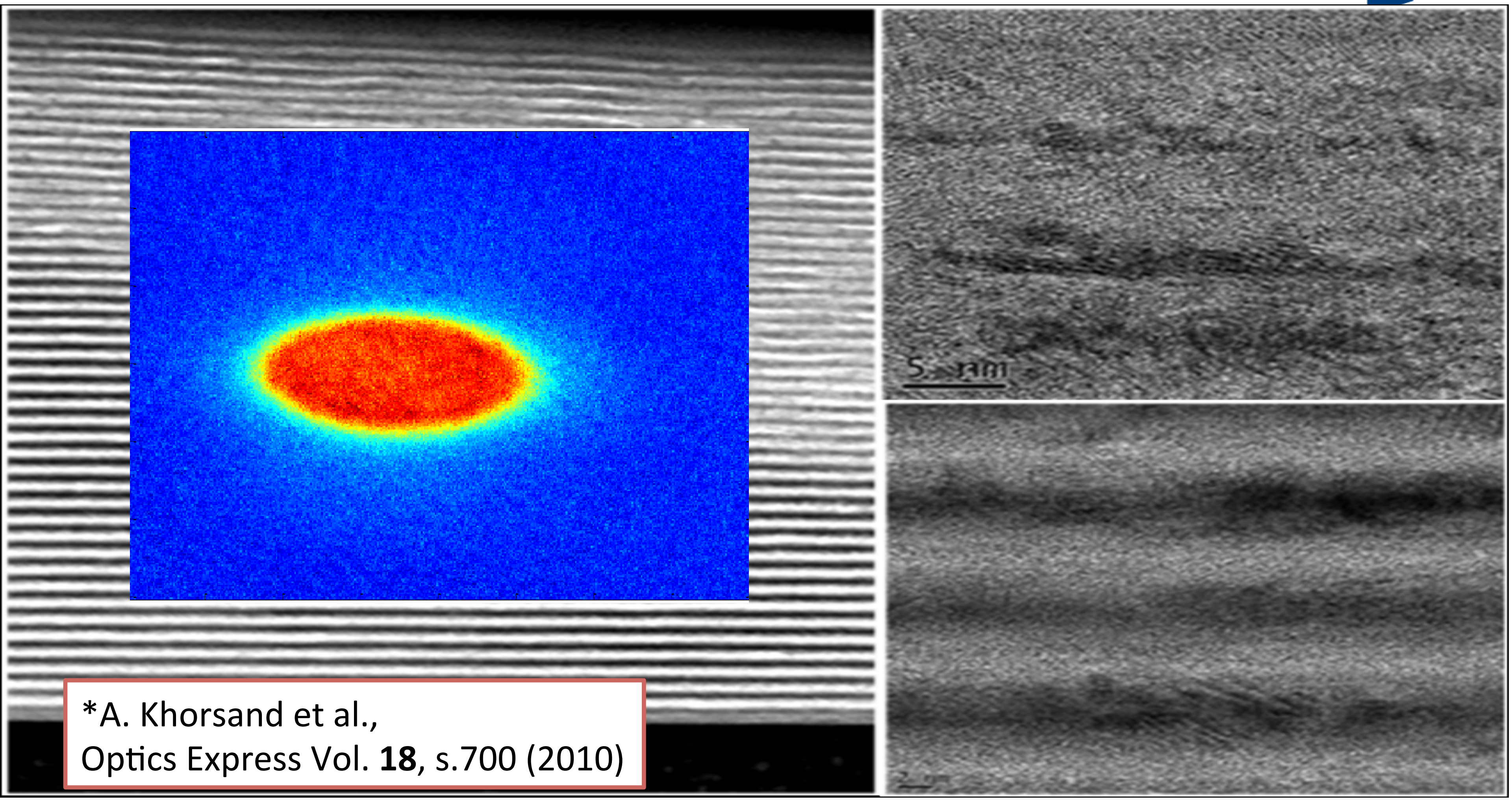
*J. Gaudin et al.,
Physical Review B 86 p.024103 (2012)

Melting c-Si @ T_i ~1650 K



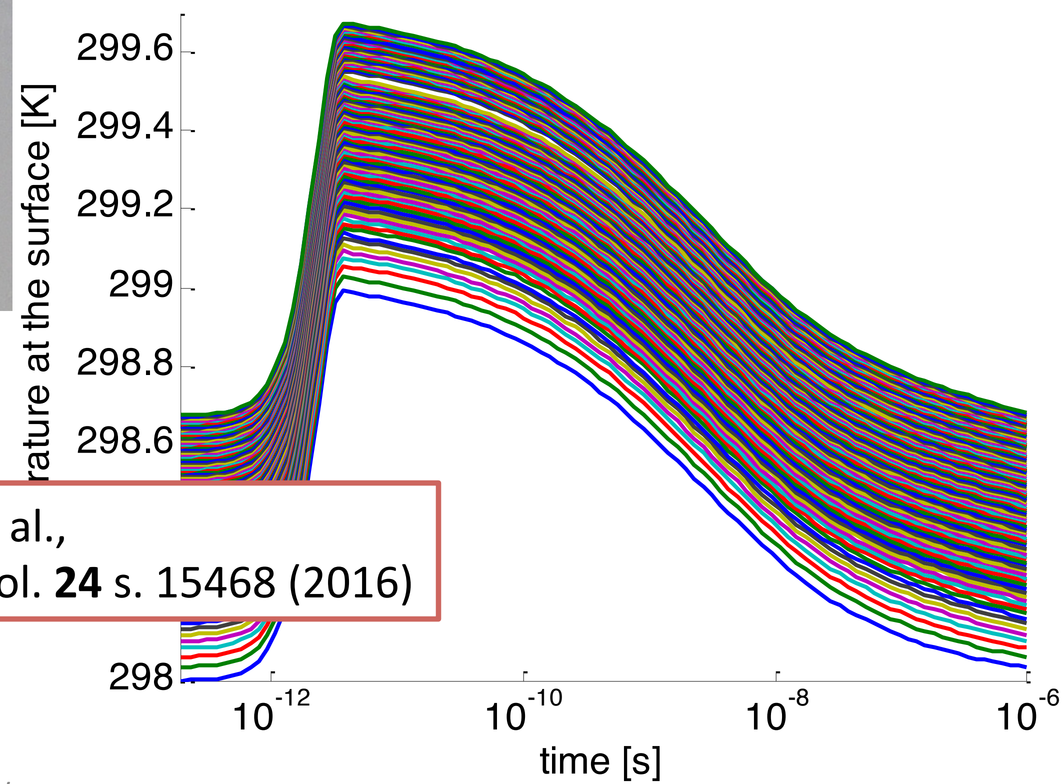
*N. Stojanovic et al.,
Appl. Phys. Lett. Vol. **89,** s.241909, (2006)

Atomic diffusion in Mo/Si multilayer



*A. Khorsand et al.,
Optics Express Vol. **18**, s.700 (2010)

Thermo-mechanichal fatigue & heat accumulation

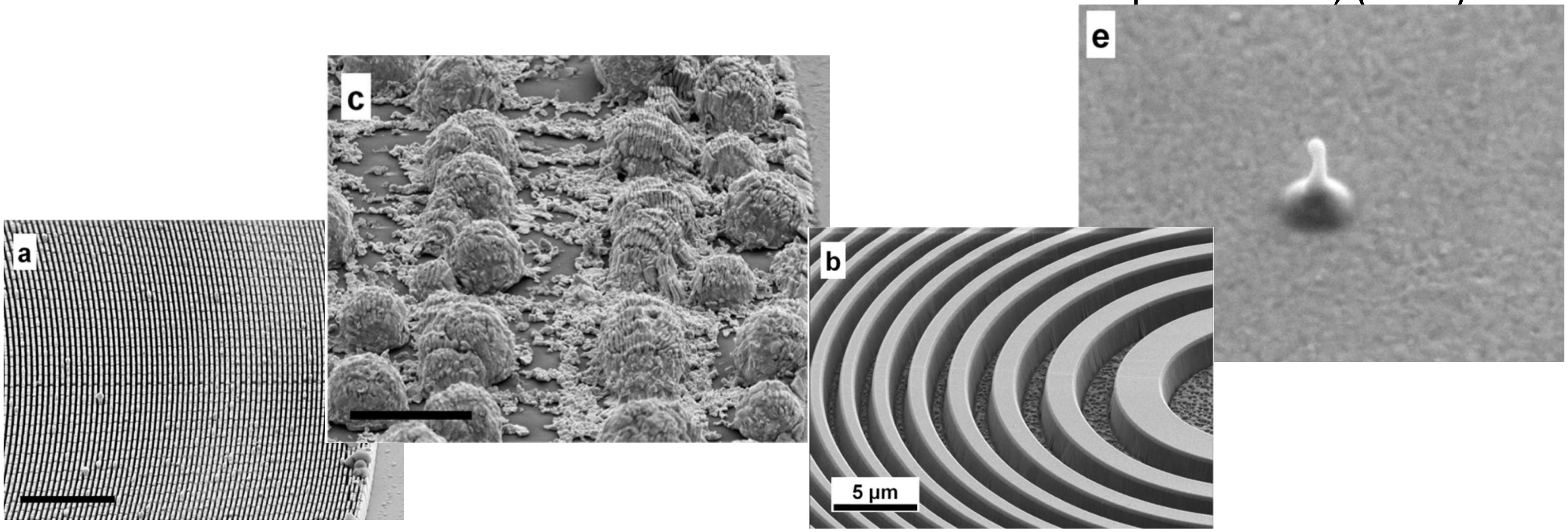


*R.Sobierajski et al.,
Optics Express Vol. **24** s. 15468 (2016)

Motivation – damage to x-ray optics

Properties of the intense x-ray beam create, apart new experimental opportunities, extreme demands to optical elements applied in the experimental equipment. Amongst the most serious issues is **radiation load** imposed on of **optics / detectors / samples.**

C. David et al. Scientific Reports Vol. **1**, (2011)



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SLAC: J. Krzywinski, S.Moeller

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XFEL: J. Gaudin, H.Sinn

FOM: R.A. Loch, E. Louis, S. Bruijn, A.R. Khorsand, R.W. E. van de Kruijs,

SPRING-8: M.Yabashi, M.Nagasono

Time resolved studies of the glass-crystal phase transitions in metals - inspiration

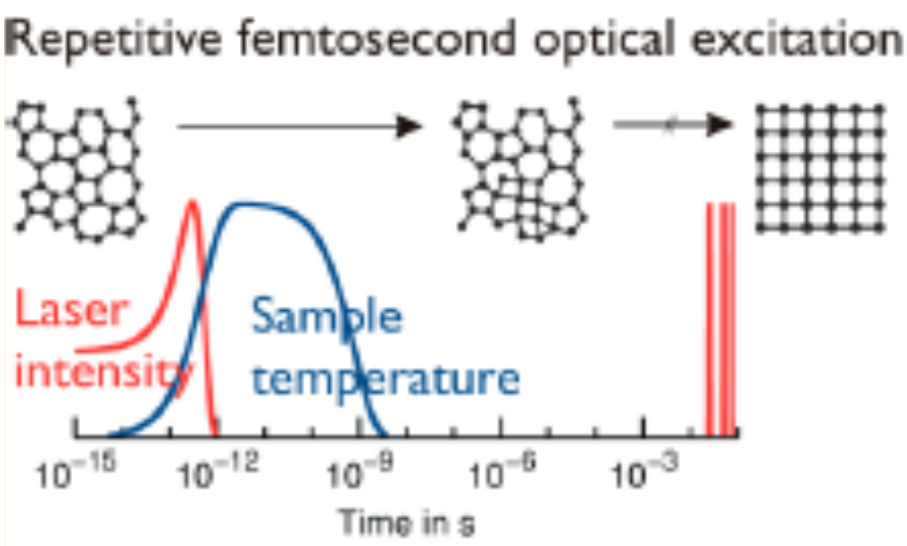
CM CHEMISTRY OF MATERIALS

Article

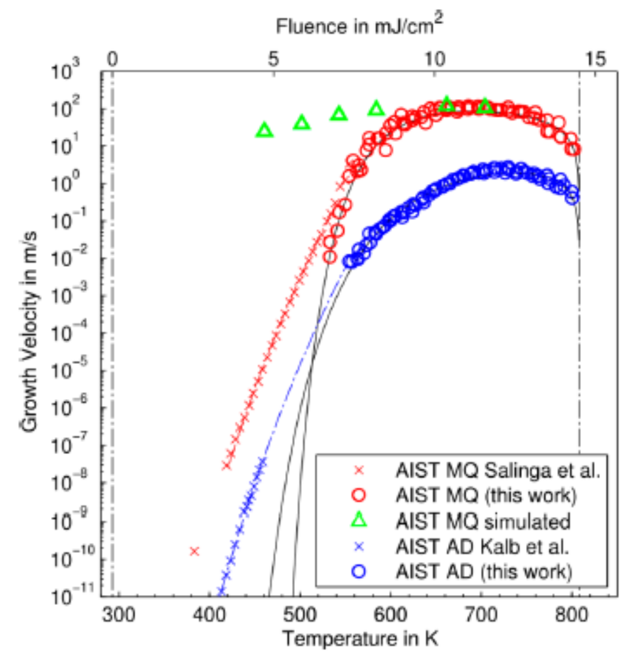
pubs.acs.org/cm

How Supercooled Liquid Phase-Change Materials Crystallize: Snapshots after Femtosecond Optical Excitation

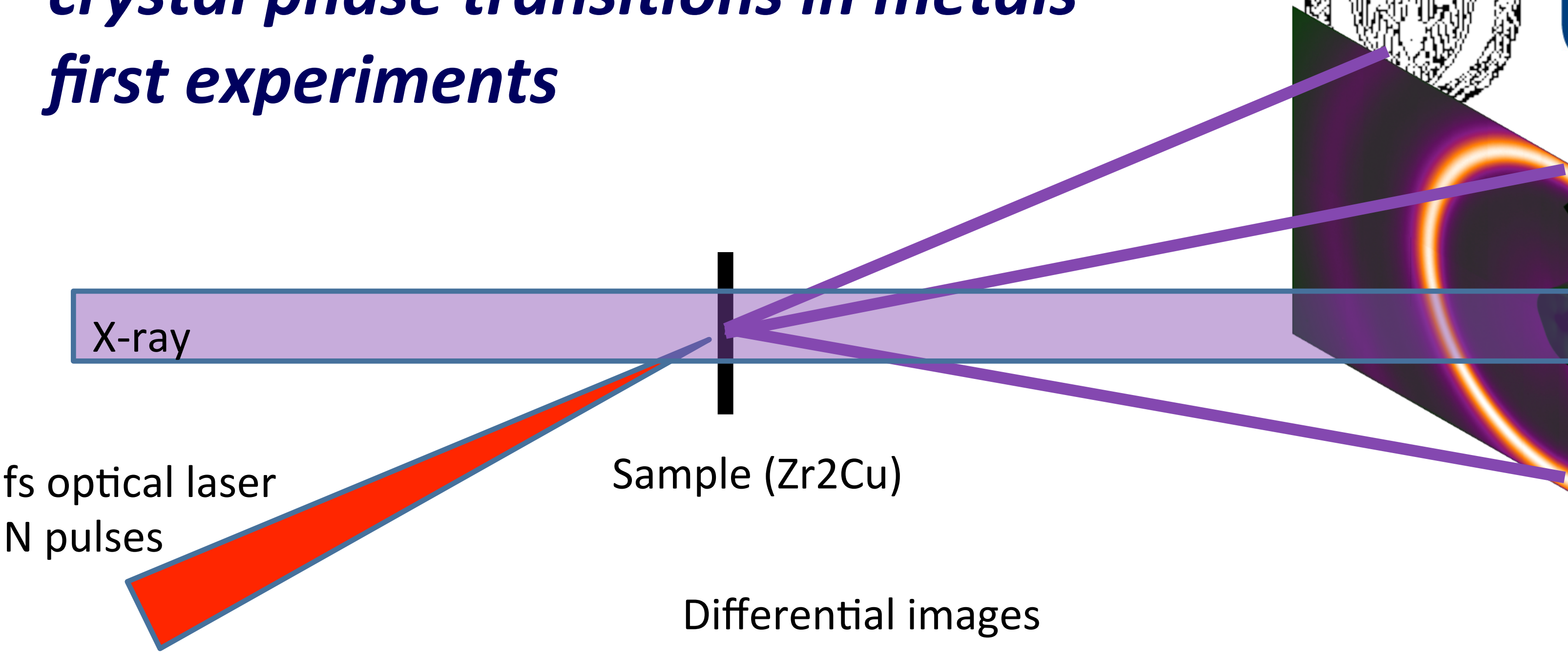
Peter Zalden,[*,†,‡,#] Alexander von Hoegen,[§] Patrick Landreman,[⊥] Matthias Wuttig,[§,∥] and Aaron M. Lindenberg[†,‡,⊥]



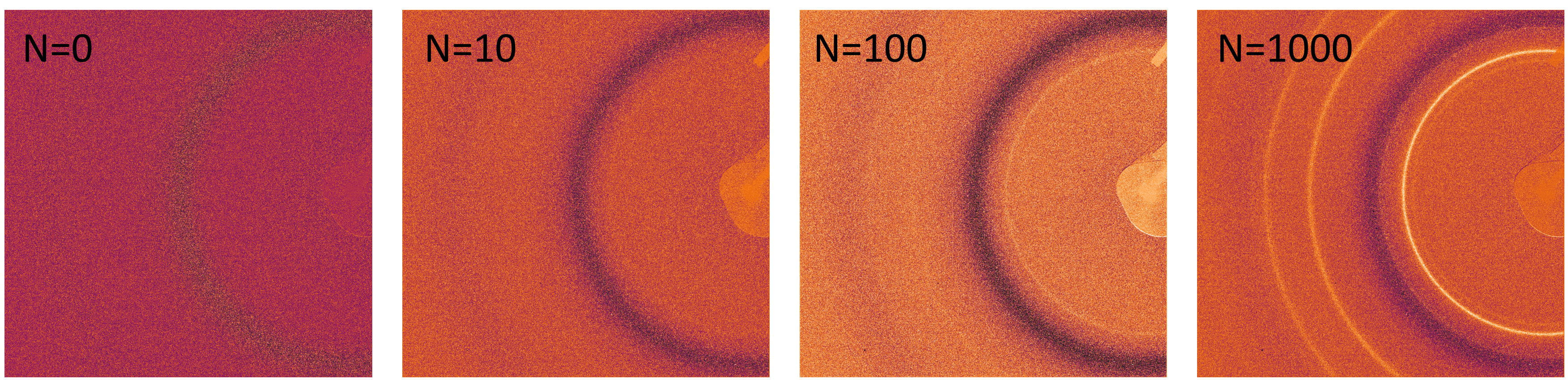
PCM $Ag_4In_3Sb_{67}Te_{26}$ (AIST)



Time resolved studies of the glass-crystal phase transitions in metals – first experiments

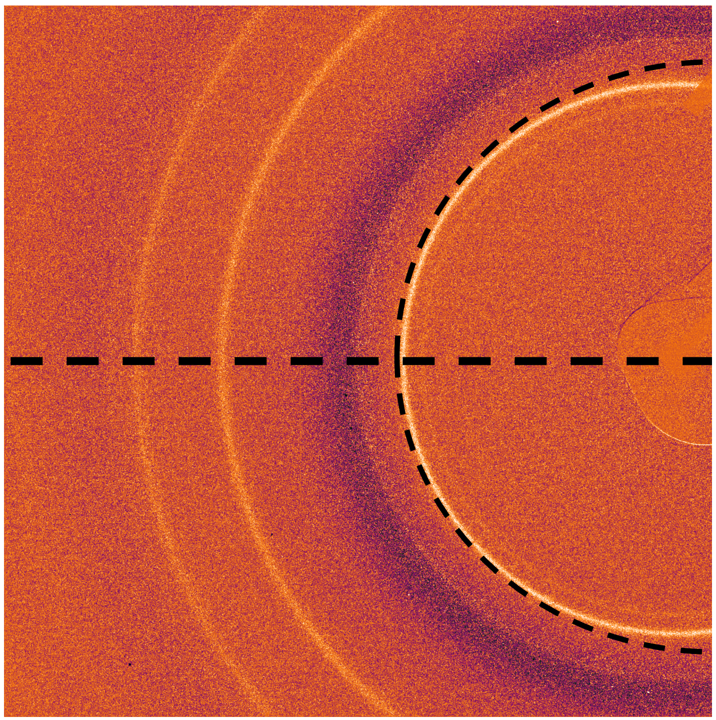


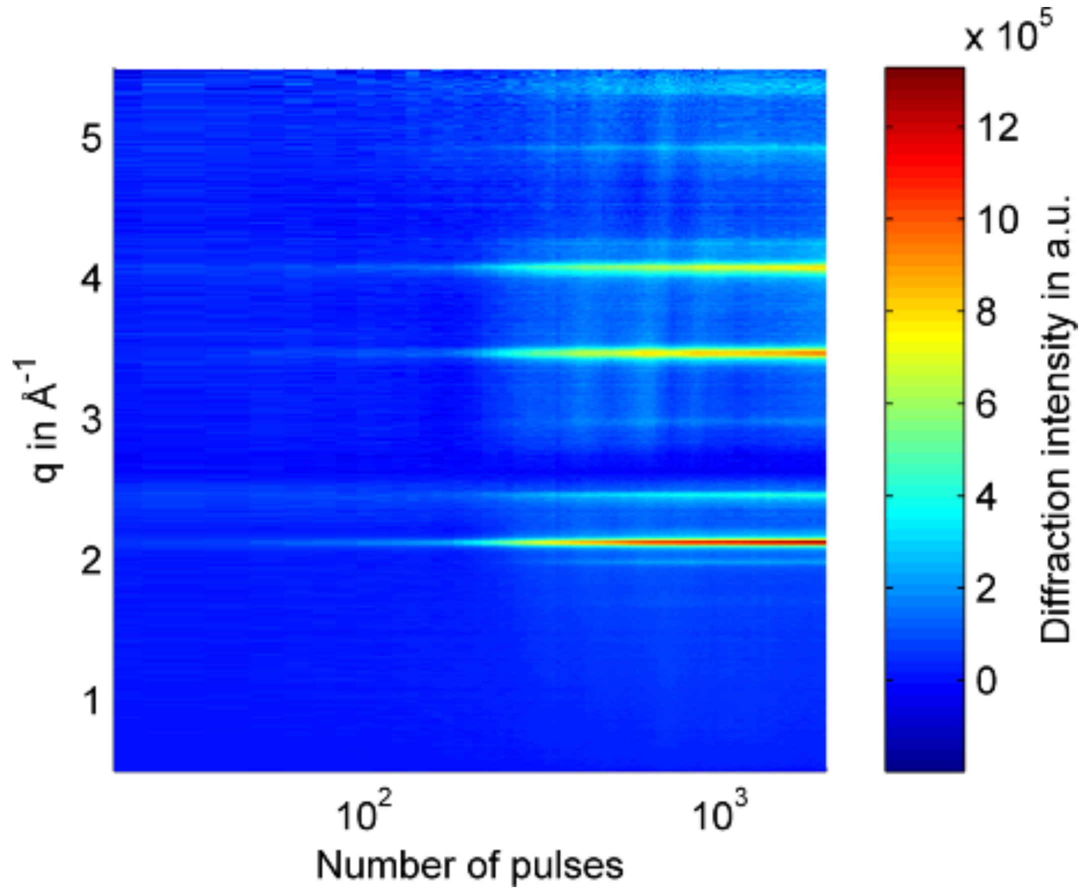
Differential images



R.Sobierajski, J.Antonowicz, P.Zalden, K. Sokolowski-Tinten, H.Fiedorowicz

Time resolved studies of the glass-crystal phase transitions in metals – first experiments





Time resolved studies of the glass-crystal phase transitions in metals – first experiments

NATURE | LETTER

日本語要約

Formation of monatomic metallic glasses through ultrafast liquid quenching

Li Zhong, Jiangwei Wang, Hongwei Sheng, Ze Zhang & Scott X. Mao

Affiliations | Contributions | Corresponding authors

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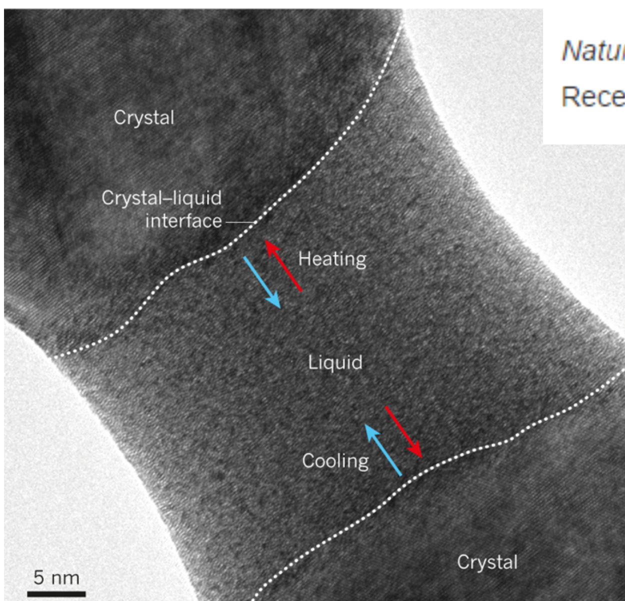

Critical cooling rate – 10^{14} K/s
Required time resolution – 10^{-11} s

→ **Pump-probe experiment during phase transition (single shot?)**

Characteristic times & processes