eV-TEM: transmission electron microscopy with few-eV electrons

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Stellingen

Behorend bij het proefschrift

"eV-TEM: Transmission Electron Microscopy with few-eV Electrons"

I. In understanding the nature of electron reflection and transmission oscillations in multilayer graphene, inelastic and elastic effects are of equal importance.

Chapters 4 and 5 of this thesis.

II. Experimental and theoretical studies of nanoscale matter have largely ignored electron states above the vacuum level, thereby limiting our understanding of the electronic properties of such systems.

Chapter 4 of this thesis.

III. The next step in eV-TEM is to improve the electron source. This will eventually allow for Electron Energy Loss Spectroscopy (EELS) with high resolution in both energy and space.

Chapter 5 of this thesis.

IV. With graphene we can simultaneously realize ~10% elastic electron transmission and reflection. Therefore, graphene can be used as an electron-beam splitter, an optical element that has always been unavailable in electron optics.

Chapter 4 of this thesis

V. Only combined measurements of low-energy electron *reflection from* and *transmission through* multilayer graphene can test the first-principles theoretical predictions by Feenstra et al.

Feenstra et al. : "Low-energy electron reflectivity from graphene" PRB 87, 041406 (2013)

VI. The assumption that electrons with an energy <5eV are not involved in the exposure processes in photolithography is wrong.

Narasimhan et al.: "What We Don't Know About EUV Exposure Mechanisms" Journal of Photopolymer Science and Technology 30 Issue 1 Pages 113-120 (2017)

VII. Not only chemical properties, but also physical properties (e.g. conductivity and the secondary electron emission coefficient) change during exposure of a resist. Resist modelling must take such changes into account.

Wisehart et al.: "Energy Deposition and Charging in EUV Lithography: Monte Carlo Studies" Proc. of SPIE Vol. 9776 97762O-1 (2016)

VIII. The claim by Longchamp et al. to have imaged proteins on the single molecule level with 50 eV electrons, and without damage, is highly surprising and probably not justified.

Longchamp et al.: "Imaging proteins at the single-molecule level." PNAS 114 (7) 1474-1479 (2017).

IX. We have come far in understanding the world around us. However, why we can understand this and why we are aware of this remains one of the largest enigmas.

Daniël Geelen

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