# Focused electron-beam-induced deposition of platinum at very low landing energies

A. Botman
*Philips Research Laboratories, High Tech Campus 34, 5656 AE Eindhoven, The Netherlands*
D. A. M. de Winter
*Utrecht University, H.R. Kruyt building, Padualaan 8, 3584 CH Utrecht, The Netherlands*
J. J. L. Mulders
*FEI Electron Optics, Achtseweg Noord 5, 5600 KA Eindhoven, The Netherlands*

Electron-beam-induced deposition[1] (EBID) allows the rapid fabrication of three-dimensional nano-devices and metallic wiring of nano-structures within a scanning electron microscope (SEM). The deposited material depends on the precursor chosen; the decomposition of the gaseous precursor is caused by the interaction of an electron beam with a solid substrate. Typical applications of EBID include contacting carbon nano-tubes[2], growing tips for field emission[3] and for magnetic force microscopy[4].

The role of secondary electrons in the precursor dissociation process is currently not well understood. We address this by directly investigating depositions created at very low landing energies, down to 10 eV. This energy range has only been explored once before, for tungsten deposition[5]. We have performed EBID of platinum from methylcyclopentadienyl-platinum-trimethyl ($MeCpPtMe_3$) in an SEM with a focused electron beam whose landing energy was varied from 10 eV to 20 keV. The growth rate of the deposited nano-structures peaks at 140 eV (see Figures 1 and 2); at this energy the deposition process is over ten times more efficient than at 20 keV. This study provides strong evidence for the dissociation process being primarily driven by the sub-20 eV secondary electrons[6].

Furthermore for the first time we demonstrate from energy dispersive X-ray (EDX) results that the composition of nano-structures created with EBID does not vary significantly with electron landing energy between 10 and 1000 eV.

---

[1] S.J. Randolph, J.D. Fowlkes and P.D. Rack, Crit. Rev. Solid State and Mat. Sci. **31**, 55–89 (2006)
[2] T. Brintlinger *et al.*, J. Vac. Sci. Technol. B **23**, 3174–3177 (2005)
[3] H.W.P. Koops, C. Schoessler, A. Kaya and M. Weber, J. Vac. Sci. Technol. B **14**, 4105–4109 (1996)
[4] Y.M. Lau, P.C. Chee, J.T.L. Thong and V. Ng, J. Vac. Sci. Technol. A **20**, 1295–1302 (2002)
[5] P.C. Hoyle, J.R.A. Cleaver, and H. Ahmed, Appl. Phys. Lett. **64**, 1448–1450 (1994)
[6] Y.R. Choi, P.D. Rack, B. Frost and D.C. Joy, Scanning **29**, 171-176 (2007)

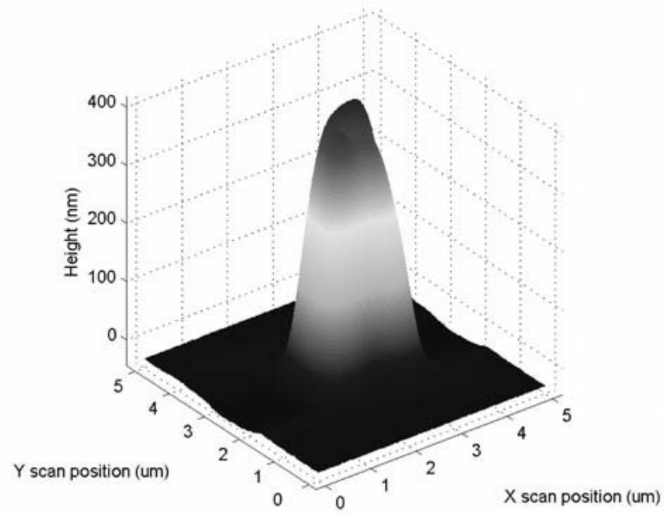


*Figure 1:* An atomic force microscopy scan of a successful EBID structure created with a focused electron beam of landing energy 80 eV.

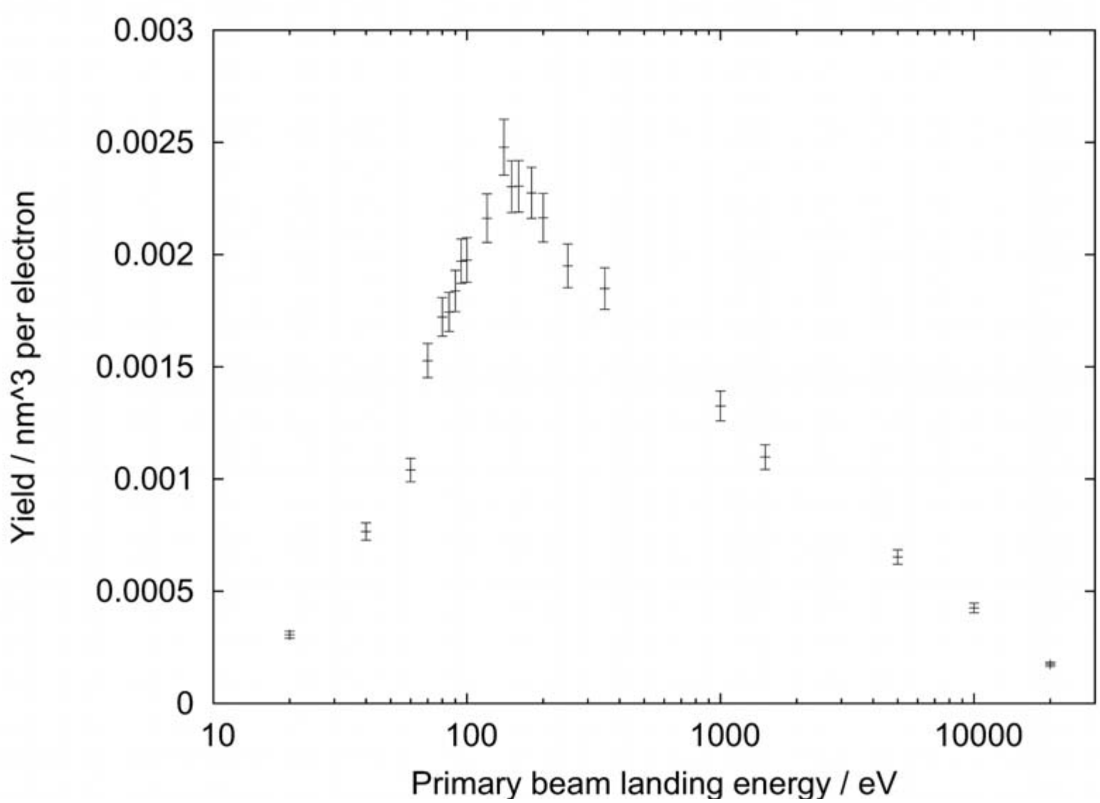


*Figure 2:* The EBID deposition yield ($nm^3$ per electron) as a function of focused electron beam landing energy (eV). The growth rate peaks at 140 eV, where the dissociation efficiency is over ten times that at the more traditional 20 keV.