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2013 Nanotechnology 24 450201

(http://iopscience.iop.org/0957-4484/24/45/450201)

Nanotechnology **24** (2013) 450201 (2pp) doi:10.1088/0957-4484/24/45/450201

EDITORIAL

An intelligent approach to nanotechnology

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Control counts for little without a guiding principle. Whether manipulating atoms with a scanning probe or controlling carrier concentration in thin film deposition, intelligent intervention is required to steer the process from aimless precision towards a finely optimized design. In this issue G M Sacha and P Varona describe how artificial intelligence approaches can help towards modelling and simulating nanosystems, increasing our grasp of the nuances of these systems and how to optimize them for specific applications [1]. More than a labour-saving technique their review also suggests how genetic algorithms and artificial neural networks can supersede existing capabilities to tackle some of the challenges in moving a range of nanotechnologies forward.

Research has made giant strides in determining not just what system parameters enhance performance but how. Nanoparticle synthesis is a typical example, where the field has shifted from simple synthesis and observation to unearthing insights as to dominating factors that can be identified and enlisted to control the morphological and chemical properties of synthesized products. One example is the neat study on reaction media viscosity for silver nanocrystal synthesis, where Park, Im and Park in Korea demonstrated a level of size control that had previously proved hard to achieve [2]. Silver nanoparticles have many potential applications including catalysis [3], sensing [4] and surface enhanced Raman scattering [5]. In their study, Park and colleagues obtain size-controlled 30 nm silver nanocrystals in a viscosity controlled medium of 1,5-pentanediol and demonstrate their use as sacrificial cores for the fabrication of a low-refractive filler.

Another nanomaterial that has barely seen an ebb in research activity over the past two decades is ZnO, with a legion of reports detailing how to produce ZnO in different nanoscale forms from rods [6], belts [7] and flowers [8] to highly ordered arrays of vertically aligned nanowires. In particular, the arrays of high aspect ratio nanowires have piqued recent interest for potential piezoelectric ‘nanogenerator’ applications. Yet just because you can does not mean you should, and as always any alleviation of the structural requirements for exploiting these systems is helpful. Interest in the piezoelectric properties motivated a theoretical and finite element analysis of the behaviour of aligned ZnO nanowires under compression by Romano and researchers in the US and Italy [9]. Their study concludes that the nanowire length does not significantly affect the output piezopotential, which as they suggest ‘is an important result for wet-chemistry fabrication of low-cost, CMOS- or MEMS-compatible nanogenerators’.

Evidently exploiting nanostructures requires an intelligent approach so that we can harness the eccentricities of their behaviour most effectively for empowering new technologies. However, as G M Sacha and P Varona point out in this issue, that intelligence need not be human [1]. They describe a number of situations—from modelling scanning probe tools and interpreting their data to extracting solutions from DNA computers—where genetic algorithms and artificial neural networks can take the place of an expert, and for some applications achieve what broaches the impossible with the methods otherwise available.

0957-4484/13/450201+02$33.00

Over the past few decades computers have infiltrated everyday life at an astonishing rate and it is widely recognized that now without them, the Western world would fall apart. Yet what machine learning and fuzzy logic may offer could trivialize even our existing machine reliance. Real implementation of artificial intelligence is so far scarce in technology. However it has been on the radar in science fiction for so long it almost sounds retro, and its popularity in dystopian futuristic novels has tinged the term with a melodrama that may seem inappropriate for science. In fact as the review in this issue illustrates, artificial intelligence and machine learning approaches already offer a potent suite of tools to nanotechnology researchers with very practical benefits. Even as far back as 1995 David Whitehouse—Editor-in-Chief of *Nanotechnology* when the journal was launched almost 25 years ago—and W L Wang reported on the relevance of neural networks in scanning probe imaging [10]. Couple the progress in applying artificial intelligence with the advances in mimicking biological neurons with nanostructures that has been highlighted in our recent synaptic electronics special issue [11] and it seems we may be on the cusp of a new phase in the relationship between man and machine.

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