

# Index

- 1,2,4-trichlorobenzene, 136  
1,2-dichlorobenzene (ODCB), 13, 141  
1,3-dipolar addition, 36  
1 m<sup>2</sup> module, 264  
1-(3-(methoxycarbonyl)propyl)-1-phenyl[6,6]-C<sub>61</sub>, 62  
3-alkyl thiophenes, 17  
5-oxo-5-phenyl-pentanoic acid methyl ester, 61  
5-toluenesulfonylhydrazono-5-phenyl-pentanoic acid methyl ester, 61  
{6}-1-(3-(methoxycarbonyl)propyl)-{5}-1-phenyl[5,6]-C<sub>61</sub>, 61  
[60]PCBM, 15, 42, 48  
[70]PCBM, 15, 37  
 $\pi$ - $\pi$  stacking, 136
- A**  
absorption coefficient, 131  
accelerated lifetime  
  measurements, 156, 217  
  apparatus, 220  
  study, 206  
acceleration factor, 219  
activation temperatures, 251  
active device area, 245  
addition of oxygen, 185  
adhesion effect, 255  
adhesive aluminum tape, 66  
adhesive forces, 133  
Ag pastes, 275  
aggregates, 138  
air, 139  
  mass, 4, 92  
airflow, 135  
Al diffusion, 143  
Al electrode, 142, 143  
Al<sup>+</sup>, 165  
Al<sup>+</sup>/In<sup>+</sup>, 177  
Al/C<sub>60</sub>/C<sub>12</sub>-PPV/PEDOT:PSS/ITO, 173  
Al/C<sub>60</sub>/P3CT/ITO, 173  
Al/P3HT:PCBM/PEDOT:PSS/ITO, 141, 143, 144  
alignment, 136  
alkyl substituted PPVs, 15  
all-in-one molecule, 40  
AlO<sub>2</sub><sup>-</sup>, 161, 166  
Alq<sub>3</sub>, 190  
aluminum, 139, 177, 267  
  oxide, 139  
AM 0, 93  
AM 1.5G, 93  
Amicon pastes, 277  
angle of attack, 236  
angular velocity, 134, 135  
annealing, 132, 133, 140, 142, 143, 146–148  
  conditions, 140  
  temperature, 140–143  
  time, 140  
anode, 266  
apparent yield stress, 248  
applying electrodes, 65  
applying filters to improve the spectrum, 100  
arc lamp, 91  
architecture, 131, 132  
Arrhenius  
  equation, 218  
  like behavior, 251  
arrival rate, 138  
  uniformity, 138  
ASTM  
  E 927-05, 94  
  E490-00, 92  
atmosphere, 135  
atomic force microscopy (AFM), 18, 144, 146, 212  
Auger spectra, 189
- B**  
background pressure, 139  
ballistic  
  deposition, 139  
  propagation, 137–139  
bandgap, 20

- barrier  
   improvement factor, 282  
   layer, 139, 155  
   materials, 280  
 batch  
   printing, 237  
   type methods, 233  
 bathocuproin (BCP), 35  
 batteries, 1  
 bendable module, 292  
 benzo-bis(thiadiazole), 28  
 benzothiadiazole, 25, 27  
 biexponential decay, 219  
 binary solvent, 135  
 Bingham fluid, 248  
 biodiesel, 5  
 bioethanol, 5  
 biofuels, 5  
 biomass energy, 3  
 bithiazole, 31  
 blend cell, 132, 136  
 boat, 137, 139  
   source, 138  
 boiling point, 136  
 bolometric power measurement, 100  
 bolometric pyranometer, 101  
 Brabec triangle, 8  
 browning phenomenon, 112  
 brushing, 135  
 bulk heterojunction, 15, 36, 146  
**C**  
 $C_{12}$ -PPV, 160  
 $C_2Al^-$ , 160  
 $C_4^-$ , 160  
 $C_{60}$ , 13  
 Ca passivation, 204  
 cadmium telluride (CdTe), 6  
 calcium, 201, 267  
   test, 283  
 calibration of the sun simulator, 103  
 capacitance, 109  
 capacitive loading, 108  
 capillary forces, 236  
 carrier substrates, 266  
 cathode, 131, 140, 266  
   aging, 210  
   degradation, 201  
 cell performance, 140  
 centrifugal forces, 133  
 characterisation  
   by NMR and UV-vis spectroscopy, 57  
   of organic solar cells, 91  
   techniques, 144  
 charge  
   carrier mobilities, 132, 135  
   mobility, 132, 140  
   transport, 140, 147  
   chemical characterization, 144  
   chemical degradation mechanisms, 183  
   chemical shifts, 189  
   chemical structure elucidation, 178  
   chemical vapor deposition, 138  
   chemically gasified solid, 138  
   chemisorption, 190  
   chlorobenzene, 141, 145–147  
   chloroform, 136, 137  
   cliché, 237  
   clothing, 304  
   clusters, 138  
   CN-MEH-PPV, 17  
   coal, 2  
   coalescence processes, 139, 141  
   collisions, 139  
   color code, 241  
   color histograms, 241  
   columnar structure, 35  
   compatibility, 135  
   concentration, 134  
   conductive inks, 275  
   conductivity, 140  
   confocal laser scanning fluorescence microscope, 216  
   contamination, 138  
   controllability, 134  
   convective flow, 135  
   cooling, 140  
     rate, 140  
   copper indium-gallium diselenide [Cu(In,Ga)Se<sub>2</sub>], 6  
   copper phthalocyanine (CuPc), 7  
   corrosion of metallic calcium, 201  
   critical shear rate, 248  
   cross section, 145  
   crystal  
     defects, 140  
     lattice, 140, 147  
     overgrowth, 144  
   crystalline order, 132  
   crystallinity, 132, 147  
   crystallographic parameters, 138  
   crystallographic properties, 140  
   crystallography, 138  
   curing glues, 287  
   current-voltage-luminance (I-V-L), 245  
   cyano substituted MEH-PPV, 15  
   cyanovinylene terphenylene, 32  
   cyclic voltammetry, 20  
**D**  
 defects, 15, 135  
 degradation  
   constant, 218

- mechanisms, 155, 210
    - using XPS, 187
  - products, 183
  - degree of coiling, 135
  - Dektak profilometer, 243
  - delaminated module, 265
  - delamination, 265
  - deposition, 133
    - behavior, 139
    - techniques, 133
  - depth
    - profiling, 158
    - scale, 145
  - determination of the molecular weight, 55
  - device
    - aging, 191
    - preparation and performance, 68
  - dielectric relaxation, 108
  - differential scanning calorimetry (DSC)
    - measurements, 142
  - diffraction pattern, 147
  - diffusion, 138, 139
    - coefficient, 280
    - free sealing techniques, 288
    - phenomena, 167
    - through the Al grains, 175
  - dilatancy, 248
  - dip coating, 135–137
  - diphenyl-dimethyl-phenanthroline, 35
  - disk, 133
  - distribution of P3CT, 172
  - DL-CuPC, 35
  - doctor blade, 237
  - doctor blading, 233, 237
  - donor-acceptor, 131
    - domains, 146
    - interface, 132
    - interpenetrating networks, 144–146
  - double-layered cells, 131
  - drop-casting, 135
  - Dryflex getter, 289
  - dust, 139
  - dyad, 40
  - dye-sensitized nanocrystalline photoelectrochemical cells, 129
- E**
- e-beam evaporation of aluminum, 264
  - Eccobond paste, 277
  - ECN solar energy, 116
  - efficiency, 132, 142–144
  - efficient encapsulation of OPV modules, 265
  - elastic recoil detection analysis (ERDA), 197
  - elasticity, 135
  - electric arc lamps, 91
  - electrical barrier layer, 140
  - electrical carrier traps, 139
  - electrical field, 107
  - electron
    - acceptor, 131, 132, 136
    - beam physical vapor deposition, 138
    - donor, 131, 132
    - microscopy, 132, 145
  - emulsion coating, 237
  - encapsulation, 279
    - and permeability, 279
    - techniques, 286
  - environmental effects, 112
  - EP patent application 93920199.2, 294
  - epoxy-based Ag paste, 277
  - epoxy-based carrier materials, 275
  - equilibrium conditions, 140
  - equivalent circuit, 231
  - evaporate, 134, 138
  - evaporating the electrode, 64
  - evaporation, 138
    - rate, 138, 139
    - time, 138
  - exciton, 131
  - exciton
    - diffusion
      - length, 131, 137
      - range, 131, 132
    - dissociation, 131, 132
  - experimental parameters, 137
  - exponential decay, 219
  - external quantum efficiency (EQE), 245
- F**
- failure mechanism, 217, 221
  - female clothing, 303
  - ferric chloride polymerization, 18
  - fiber-optic/minidish concentrator, 129
  - Fick's first law, 280
  - film
    - splitting, 255
    - thickness, 134, 138
  - fish-bone diagram, 239
  - flakes, 139
  - flat-panel displays, 269
  - flexibility, 280
  - flexible
    - encasement, 290
    - foils, 257
    - PET foil, 303
  - flexible ultrabARRIER material, 292
  - flexo/pad printing, 233
  - flexography, 234, 239
  - flow
    - coating, 135

- curve, 247  
 fluorene, 29  
 fluorescence, 216  
   images, 216  
   microscopy, 216  
   screen, 145  
 flywheels, 1  
 fossil fuel, 1  
 fragment ion, 184
- G**
- G24i, 293  
 gallium arsenide (GaAs), 6  
 gas-phase ion chemistry, 183  
 gelation phenomena, 250  
 geometric fill factors, 263  
 geothermal energy, 3  
 getter materials, 286  
 Gilch  
   polymerization, 15  
   reaction, 14  
 glass transition temperature, 140, 142  
 glove box, 68  
 gold, 139  
 grain, 140  
   boundaries, 139, 140  
   growth, 140  
   sizes, 139  
 gravure, 234, 239  
 growth, 138
- H**
- $\text{H}_2^{18}\text{O}$ , 159, 222  
 halogen lamps, 97  
 hardness, 140  
 head-to-tail, 17  
 heating boat, 138  
 heating coil, 138  
 Heck-type coupling, 15  
 height resolution, 146  
 hexabenzocoronene, 35  
 high carrier mobility, 15  
 high-performance liquid  
   chromatography (HPLC), 52  
 high-power spectrometer, 109  
 high-sensitivity permeation instruments,  
   283  
 highly conductive PEDOT  
   (HC-PEDOT), 269  
 history of degradation, 185  
 hole acceptor poly(9,9-dioctylfluorene-  
   co-bis-N,N-(4-butylphenyl)-bis-  
   N,N-phenyl-1,4-phenylenediamine,  
   136  
 homopolymers, 137  
 Horner-Wadsworth-Emmons reaction,  
   15
- human energy consumption, 1  
 hydrogen, 1  
 hydropower, 3
- I**
- IEC 904-9 standard, 94  
 impedance, 109  
 impurities, 133, 139  
 $\text{In}^+$ , 165  
 $\text{In}^+/\text{Al}^+$ , 177  
 incident photon to current efficiency,  
   110  
 incorporate dopants, 140  
 incorporated, 138  
 INDEX 2005 prize, 305  
 indium, 177  
   tin oxide, 267  
 induced strain, 247  
 ink, 234  
   formulation, 245  
   jet printing, 234, 239  
   paste, 239  
 $\text{InO}_2^-$ , 166  
 inorganic transparent conductive oxide,  
   267  
 insulator, 140  
 integration of solar cells, 229  
 intellectual property rights, 293  
 intensity distribution patterns, 176  
 interaction chromatography, 52  
 interchain spacing, 147  
 interdigitated alkyl chains, 147  
 interface, 131, 133  
    $\text{Al}/\text{C}_{60}$ , 166  
    $\text{Al}/\text{LiF}$ , 196  
    $\text{Al}/\text{P3HT}:\text{PCBM}$ , 142  
   chemistry, 166  
   ITO, 175  
 interfacial  
   area, 132  
   contact area, 143  
 interference microscopy, 211  
 interlayer  
   diffusion, 155, 167  
   mixing, 165  
 internal stress, 140  
 interpenetrating network, 132  
 intramolecular charge transport, 132  
 IPCE measurements, 110  
 IPR portfolio, 293  
 isothianaphthene (ITN), 27  
 isotope labeling, 156, 159, 220  
 isotopic markers, 201  
 isotopically labeled water, 222  
 Israeli Meteorological Service, 115  
 Israeli National Physical Laboratory,  
   115

**J**

JP-20006-080530A, 294  
junction, 132

**K**

Keithley 2400, 67  
Konarka Inc., 293  
Kumada coupling, 17

**L**

lamella microstructures, 136  
laminated, 261  
lamination, 280  
Langmuir–Blodgett technique, 33  
large module, 262  
large rigid encasement, 289  
larger screen printed photovoltaic module based on MEH-PPV, 260  
lateral resolution, 145, 146  
LED, 245  
letterpress, 239  
Li and F distribution, 193  
LiF layer, 190  
lifetime, 155  
light source, 91  
linear decay, 219  
Linz Institute for Organic Solar Cells, 116  
liquid crystalline display (LCD) panels, 269  
liquid-vapor interface, 134  
lithographic, 239  
long-term characterization, 113  
long-term outdoor testing of stability of organic solar cells, 123  
low-conductive PEDOT, 270

**M**

magnesium, 267  
MALDI-TOF, 157  
mapping the history of degradation, 185  
mask, 137, 235  
mass spectral information, 178  
mass spectral marker, 160  
mass spectral markers, 165  
mass spectrometry, 285  
materials, 47  
matrix, 145  
McCullough route, 17  
MDMO-PPV, 12  
MDMO-PPV:PCBM, 145, 147  
measurement  
  of permeability, 279  
  of the diffusion coefficient, 281  
mechanical barrier, 261  
mechanical flexibility, 268

mechanism for the particle formation, 181  
median color code, 241  
MEH-PPV, 12, 190  
MEH-PPV:PCBM, 164  
mesh size, 243  
mesoscopic order, 132  
metal, 137  
  alloys, 137  
  evaporator, 42  
metallic grid, 272  
microcrystalline structures, 136  
microscopic holes, 212  
microstructure, 136, 140  
millimeter range, 145  
miscibility, 132  
mismatched cells, 231  
mobility, 136, 138  
molecular diffusion, 139, 141  
molecular ordering, 132, 136, 147  
molecular packing, 132, 140  
molecules, 34  
monitor, 144  
monitoring photooxidation, 185  
monocrystalline silicon solar cell, 6, 120  
monolithic production, 229  
morphological control, 141  
morphological controllability, 135  
morphological parameters, 134  
morphology, 131–133, 136, 137, 141, 142, 144, 145  
mottle, 241

**N**

nanometer range, 145  
nanoscale  
  interpenetrating network, 132  
  morphology, 132  
  phase-separation, 136  
nanostructure, 146  
natural gas, 2  
Negev Desert, 113  
Newtonian fluid, 247  
Newtonian plateau, 248  
non-Newtonian behavior, 134, 247  
nuclear fusion, 2  
  reactors, 2  
nuclear reaction analysis (NRA), 197, 202  
nucleation, 138–141  
nylon, 234

**O**

<sup>18</sup>O incorporation, 163  
<sup>18</sup>O incorporation/exchange, 176  
<sup>18</sup>O<sub>2</sub>, 159, 222

- $^{18}\text{O}_2$  gas cylinder, 222  
 $^{18}\text{O}/^{16}\text{O}$  ratio, 159  
ocean energy, 3  
offset, 234  
  printing, 135  
oil, 2  
OLED, 14, 301  
oligomers, 34, 38  
oligophenylenevinylene, 38, 39  
oligothiophenes, 41  
one-dimensional patterns, 238  
operational lifetime, 218  
optical microscopy, 133  
optical spectrum analyzers, 99  
optoelectronic devices, 246, 268  
Orgacon EL-P 3040, 271  
organic photovoltaics (OPV), 301  
  into clothing, 303  
other printing methods, 239  
outdoor IV measurements, 120  
outdoor measurements, 112  
outdoor solar irradiance, 124  
outside test, 265  
oxidative ferric chloride polymerization, 26  
oxide, 139  
oxido-de-sulfonato substitution, 181  
oxygen, 139, 155  
  accumulation, 193  
  and/or water reaction products, 180  
  diffusion, 161, 167, 211  
  incorporation, 203  
  permeation in PEDOT, 285  
  transmission rate (OTR), 286  
ozone treater, 46
- P**  
P3HT, 136, 141, 142  
  crystal structure, 147, 148  
  purification of the crude, 52  
P3HT:PCBM, 147, 148  
pad printing, 237  
parallel connection of solar cells, 231  
particle formation, 155  
  in organic solar cells, 178  
paste volume, 235  
PBBT, 28  
PBPT, 27  
PBT, 25  
PCBM, 13, 36, 141  
  aggregates, 142  
PCBM:polyfluorene solar cells, 123  
PEDOT:PSS, 13, 46, 141  
Peltier element, 250  
PEOPT, 18  
percolated pathways, 132  
permeability coefficient, 280  
perylene tetracarboxylic acid (PTCA), 7  
PET, 257  
PF, 29  
PFO, 190  
phase  
  separation, 137  
  -separated networks, 147  
photodegradation, 155, 189  
photo-oxidation, 210  
photophysics, 131, 132  
photoresist, 271  
photosensitive emulsion layer, 235  
photovoltaic performance, 132, 141, 142  
phthalocyanine, 35  
physical processes, 137  
physical vapor deposition, 138  
physicochemical properties, 132, 140  
plateless, 239  
PLEDs (polymer light-emitting diodes), 14, 301  
poly(3,4-ethylenedioxythiophene), 13  
poly(3-carboxydithiophene) (P3CT), 156, 162  
  marker profiles, 163  
poly(3-hexylthiophene), 49  
poly(9,9-dioctyl-fluorene), 190  
poly(9,9-dioctylfluorene-co-benzothiadiazole), 136  
polycrystalline film, 139  
polycrystalline silicon cells, 6  
polyester, 234  
poly(ethylene-terephthalate), 266  
poly(ethylenenaphthalate), 266  
poly(isothianaphthene) (PITN), 25  
poly(isothianaphthene) (PITN) with a monomer of a benzene ring fused to a thiophene, 26  
polymer  
  chain, 137  
  compatibility, 135  
  solar cell from scratch, 42  
  -solvent compatibility, 135  
  interactions, 135  
poly(phenylenevinylenes) (PPV), 12, 13  
polystyrene-polydimethylsiloxane, 31  
poly(styrenesulfonate), 13  
poly(thiophenes), 17  
polyurethane, 236  
POMeOPT, 18  
porphyrin, 32  
powder diffraction, 147  
practical fabrication, 42  
Prato reaction, 38

- pressure-curtain coating, 135  
 pressure-sensitive adhesive layer, 279  
 primary electron beam, 145  
 principle of spin coating, 133  
 print conditions, 239  
 printing  
   and coating methods, 232  
   frame, 235  
   speed, 240, 255  
   the active layer, 239  
 process parameters, 138  
 processing and production of large modules, 229  
 processing conditions, 141  
 processing of the opaque back-side contact, 274  
 processing of the transparent front-side contact, 267  
 production and companies 2007, 291  
 profilometric measurements, 241  
 protective barrier, 210  
 protrusions, 212  
 pseudo-plasticity, 247  
 pseudo-plastic flow, 253  
 PSS derivative, 181  
 PTOPT, 18  
 PTP, 28  
 PTV, 30  
 pulsed laser deposition, 138  
 pyranometer, 115, 265  
 pyrrole, 27
- Q**  
 quantum yield, 132  
 quasi-solid-state dye-sensitized solar cells, 127  
 quinoid resonance structure, 27
- R**  
 R2R coating, 232  
 radial flow, 134  
 reactive oxygen plasma, 267  
 reciprocal space, 147  
 recombination, 131, 141  
 recording the spectrum, 99  
 recovery effect, 127  
 recrystallization, 140  
 rectification ratio, 74  
 red-green-blue color scheme, 241  
 regiorandom P3HT, 18, 49  
 regioregular, 17, 42  
   P3HT, 13, 141  
   P3HT via the McCollough route, 50  
   P3HT:PCBM, 146  
 relative humidity, 135  
 removal of Al electrode, 167  
 removal of the C<sub>60</sub> and C<sub>12</sub>-PPV layers, 168  
 removal of the PEDOT:PSS layer, 168  
 renewable energy sources, 2  
 rheological characterization, 246  
 rheological properties, 134  
 rheology, 246  
 rheometer, 249  
 rheopexy, 249  
 Rieke-zinc, 17  
 rigid encapsulation, 279  
 rigid encasement, 287  
 roll-to-roll coating, 232  
 roller coating, 135  
 rotary screen printing, 234  
 rotational acceleration, 134  
 roughness, 138  
 rubber, 236  
 ruthenium terpyridine complex, 40  
 Rutherford backscattering spectroscopy (RBS), 156, 197
- S**  
 S<sup>-</sup>, 163  
 SAES getters, 289  
 scale of phase separation, 146  
 scanning electron microscopy (SEM), 144, 213  
   image, 145, 214  
 scanning probe microscopy, 132  
 scattering techniques, 133  
 Schottky, 131  
 screen printed active layer, 254  
 screen printed layers of donor/acceptor blends, 254  
 screen printed MEH-PPV, 261  
 screen printed OPV, 304  
 screen printed silver connections, 261  
 screen printing, 233, 234, 239  
 SEC chromatogram, 55  
 secondary electron image, 145  
 secondary electrons, 145  
 Sede Boker, 113  
 self-assembling, 32  
 self-organize, 135  
 self-organizing molecular materials, 35  
 self-organizing properties, 136  
 semiautomatic screen printer, 254  
 semiconducting polymer, 136  
 series connection, 230  
 series resistance, 144  
 sewing flexible PV, 303  
 shadow mask, 245  
 shear rate-dependent viscosity measurements, 252  
 shear thinning, 134, 247  
 shear-thickening, 248  
 shear-thinning regime, 252

- shearing stress, 247  
 sheering, 134  
 sheet resistance, 257  
 sheet resistivities, 267  
 shelf life, 218  
 Si photodiode, 245  
 Siegrist reaction, 31  
 Siemens AG, 293  
 silicon solar cell, 6  
 SIMNRA, 200  
 SIMS ionization process, 157  
 single-crystal diffraction, 147  
 single-layer cells, 131  
 single-layer device, 131  
 size-exclusion chromatography, 52  
 skin, 135  
 skinning, 135  
 small rigid encasement, 287  
 small screen printed module, 261  
 snap-off distance, 236, 244  
 solar  
   energy, 3, 4  
   irradiance, 117  
   simulator, 97  
   spectrum, 19  
 Solarcoating Machinery GmbH (SCM),  
   293, 295  
 Solarkonstant 575, 67  
 solubility coefficient, 280  
 solution  
   concentration, 134  
   viscosity, 134  
 solvent, 134, 145, 146  
   evaporation, 134–136, 141  
   -solvent interactions, 135  
   vapor, 135  
   volatility, 135, 136  
 Soret band, 32  
 source  
   meter, 67, 106  
   temperature, 138, 139  
 spheres, 145  
 spherical P3HT nanostructures, 146  
 spin casting, 133  
 spin coating, 132, 133, 135, 136, 233  
   parameters, 136  
   processes, 133  
 spin speed, 133, 134  
 spray coating, 135  
 sputter deposition, 138  
 squeegee, 236  
   blade, 236  
   edge profile, 236  
   pressure, 244  
 stability, 155  
   and lifetime of organic solar cells,  
   113  
 standard test conditions, 113  
 stepwise and unidirectional synthesis,  
   39  
 Steuernagel Lichttechnik GmbH, 67  
 Stille cross-coupling reaction, 27  
 strength, 140  
 structure, 133  
 SubPc, 35  
 substrate, 43  
   reactivity, 138  
   temperature, 137–139, 141  
 sulfonium precursor route, 13  
 sun simulator, 67  
 surface segregation, 167  
 surface topography, 135  
 Suzuki cross-coupling polymerization,  
   27  
 synthesis and purification of PCBM,  
   58
- T**
- taking the sun inside, 91  
 Tang, 7  
 TE, 137  
 TEM, 144, 145  
 temperature  
   dependence of the photovoltaic  
   parameters, 116  
   -dependent viscosity measurements,  
   250  
 temporal stability, 97  
 thermal annealing, 141  
   time, 144  
 thermal degradation, 155  
 thermal evaporation, 132, 133, 137,  
   141  
 thermal evaporation of aluminum, 264  
 thermal evaporator, 42  
 thermocleavable materials, 33  
 thermocleavage reaction, 34  
 thermodegradation, 189  
 thermosetting silver epoxy, 66  
 thiadiazolequinoxaline, 29  
 thin film, 133, 134  
 thin film-technologies, 6  
 thixotropy, 249  
 titanium, 267  
 TOF-SIMS, 156  
   depth profiling, 159, 166  
   imaging, 167, 170, 174  
 toluene, 145, 147  
 topographic map, 146, 211  
 topography, 138  
 transparency, 280  
   effect, 145  
 transparent oxides, 267  
 tritiated water, 285



two-component system, 275  
types of simulators, 97

## U

ultrabARRIER materials, 266  
ultrasonic bath, 46  
unification challenge, 9  
uniformity, 134, 138–140  
University of California, 294  
U.S. application 07/930,161, 294  
U.S. patents, 293  
    No. 5,331,183, 293, 294  
    No. 5,454,880, 293  
UV photolithography, 245

## V

vacuum  
    chamber, 137  
    evaporation, 137  
    thermal evaporation, 137  
vapor, 139  
    deposition, 137  
vertical distribution, 167  
vertical phase segregation, 141  
viscosity, 134, 247  
    curve, 247  
voids, 139  
volatile solvents, 134

## W

water, 139, 155  
    vapor, 201  
wetting agents, 236  
wind energy, 3  
withdrawal speed, 135  
WO/1994/005045, 294  
World Meteorological Standard, 115  
woven fabric, 234  
WVTR, 280

## X

x-ray, 144, 147  
    diffraction (XRD), 147  
    grazing-incidence, 18  
    spectra, 148  
    photoelectron spectroscopy (XPS),  
        156, 157, 187  
    principle, 188  
    spectra, 189  
xenon arc lamp, 111  
xylene, 136, 137

## Y

Yamamoto coupling, 27

## Z

zero-shear viscosity, 248  
zinc-porphyrin, 40



**Frederik C. Krebs** began his university studies in Aberdeen (Scotland) where he obtained bachelor-of-science degrees in chemistry (1993) and biochemistry/immunology (1994). He then went to Université de Nantes (France) where he obtained a DEA (1995) in the areas of solid state chemistry. He returned to Denmark and studied dielectric materials with pyroelectric properties leading to a Cand. Scient. degree (1996). Further work centered on the synthesis of organic dielectrics with a polar axis and studies of their crystals by both neutron and synchrotron x-ray methods led to a Ph.D. (2000) at the Technical University

of Denmark. Post doctoral studies at Risø National laboratory (2001–2002) were directed toward plastic solar cells starting mainly with synthetic efforts and materials characterization using synchrotron based ultraviolet photoelectron spectroscopy and mobility measurements employing transient microwave measurements by radiation doping through irradiation with high energy electrons. He was then employed as Senior Scientist at Risø National Laboratory (2002–present) and today the efforts are concentrated on large-scale preparation of polymer photovoltaic devices and their characterization. His group currently has three areas of focus; synthesis of materials with low band gap and properties that give stable solar cells and that can be processed, stability and degradation studies using sensitive techniques with the aim of improving polymer solar cells stability, processes and techniques for producing large area polymer solar cells. Currently he acts as associate editor for the international journal *Solar Energy Materials and Solar Cells* and has published more than 160 peer reviewed papers, conference proceedings, editorials, book reviews, patents and reports.



**Tom Aernouts** received his master-of-science degree in physics in 1999 from the Katholieke Universiteit Leuven on the characterization and simulation of organic oligomer-based diode structures. Continuing the research on organic semiconductors, he joined the organic photovoltaics group at the Interuniversity Micro-Electronics Center (IMEC) in Leuven, Belgium, where his work focused on the processing and characterization of polymer-based organic solar cells and monolithic modules, which resulted in several journal publications, conference contributions and invited talks. In September 2006, he received his Ph.D.

degree on this topic from the Katholieke Universiteit Leuven. Dr. Aernouts is currently a senior scientist at IMEC, supervising the polymer-based work at the

Organic Photovoltaics group. His main research interest is in the introduction of printing technology in this field.



**Rémi de Bettignies** graduated from the engineering schools Ecole Supérieure d'Electricité (Supélec, Paris) in 2000, majoring in electronics and solid-state physics. In parallel, he obtained in 2000 a DEA (Diplômes D'Etudes Approfondies) from University Paris VI in optoelectronics. He received his Ph.D. in 2003 from the University of Angers at the Organic Photovoltaic Solar Cells group, directed by J.M. Nunzy and J. Roncali. From 2003 to 2005, he worked as a postdoctoral fellow in the Laboratory of Organic Components at the CEA/DRT (Saclay), where he studied the modelling of organic solar cells

and the ageing processes. He has authored two patents and several publications. Since 2005, he has been working for the CEA-INES laboratory, the French National Institute for Solar Energy, in Chambéry, on organic photovoltaic solar cells.



**Eva Bundgaard** graduated from the Technical University of Denmark (DTU) in 2003 as a master of science in chemistry, specializing in organic chemistry, where she conducted several projects concerning, for example, synthesis of pectin (carbohydrate chemistry) and natural compounds from carbohydrates (metal-organometal-chemistry). In 2004, she began her Ph.D. project at Risø National Laboratory and Roskilde University Centre (RUC), focusing on the synthesis of low band-gap polymers for organic photovoltaics. She received her Ph.D. in 2007 and is currently working at Risø National Laboratory as a post.doc. While studying

at both DTU and at Risø National Laboratory, she has conducted research projects abroad. At the Macquarie University in Sydney in 2002, the research project focused on the synthesis of a novel human UV filter compound. She also spent six months at the National Renewable Energy Laboratory in Colorado, U.S., in 2006 where she conducted research in organic photovoltaics with low band-gap polymers she prepared at Risø National Laboratory. Ms. Bundgaard has published six peer-reviewed journal papers and three peer-reviewed proceedings papers within the field of organic synthesis, organic photovoltaics, and low band-gap polymers.



**Stéphane Cros** obtained a DEA (Diplôme D'Etudes Approfondies) in physics of solids in 1998, and entered in 2002 a Ph.D. program in ESPCI (Ecole Supérieure de Physique et de Chimie Industrielle) in Paris emphasizing synthesis and mechanical properties of multilayered PMMA-nanosilica materials by interface modification. In parallel of the first year of his Ph.D. thesis, he obtained a DEA from Université Pierre & Marie Curie (Paris VI) in macromolecular physics and chemistry. He received his Ph.D. in 2002 and joined an ATER position (research and teaching) in the Laboratory of Macromolecular Materials at the

CNAM (Conservatoire National des Arts et Métiers) in Paris where I focused on industrial polymer processing and characterisation. He then spent 6 months working on polymer blends for the CRITT Picardie (center of technology transfer) to write a technical rapport for PME (little firms). In 2004, Dr. Cros joined a postdoctoral position in the Laboratory of Organic Components at the CEA-Saclay, where he studied the barrier properties of sealing materials for organic solar cells. His research interest was focused on organic-inorganic multilayered materials, permeability measurement with a new experimental permeameter and ion beam analysis of the degradation of inorganic layers. He currently has a permanent position in the CEA-INES laboratory, the French National Institute for Solar Energy, in Chambéry with the same research subjects.



**Muriel Firon** received her Ph.D. in physical chemistry at the University of Paris VI in 1994, while working for IBM. She worked on plasma deposition processes (RFPECVD) and contributed to optimizing steps of semiconductor production. In June of 1995 she began working on the deposition and electrical characterization of thin silicon oxide films deposited by PECVD (DECR plasma) at Pr. Bernard AGIUS laboratory (University of Paris XI Orsay). She then joined the CEA/DAM in 1995 and was in charge of the development of thin solid films deposited by PVD on large plastic areas with roll-to-roll processing for

optical applications. In 2000, she joined the Physics of Accelerator Group to work on the ageing of nuclear and nonnuclear materials with ion and electron beams (0.5 MeV–6 MeV). Since 2002, she has worked at the CEA/DRT (Saclay) on the development and the characterization of plastic solar cells. Her research interests were focused on organic-inorganic interfaces in multilayers or nanocomposite materials, ageing mechanisms of organic layers and photovoltaic organic devices and

ion beam analysis. She has authored four patents and several publications. In 2006, she joined the Nuclear Energy Direction to manage R&D projects on conditioning, storage, and disposal of nuclear waste.



**Mikkel Jørgensen** obtained his Ph.D. in organic chemistry in 1990 from the University of Copenhagen emphasizing the synthesis and characterization of new organic compounds/polymers with applications in materials science. During positions as an industrial chemist he investigated stable, nontoxic organic radicals for use as contrast agents in new types of magnetic resonance imaging (MRI) (NycoMed 1987–1990); synthesis of peptide nucleic acids (PNA analogues of DNA) (PNA Diagnostics, 1990) to be used as diagnostic probes; new redox active polymers with application in electrochromic windows. After obtaining a position as senior scientist at Risø National Laboratory in 1994, Dr. Jørgensen, has investigated molecular recognition and self-assembly and utilized it for construction of sensor molecules for biologically interesting analytes such as glucose, creatinine, and ephedrine. In 2003, he became involved in the organic solar cell programme led by Frederik C. Krebs. This has involved a lot of fascinating organic chemistry on conjugated polymers and oligomers, which has resulted in more than 70 articles and patents.



**Eugene A. Katz** received his master-of-science degree in semiconductor materials science in 1982, and his Ph.D. in physics in 1990 from the Moscow Institute of Steel and Alloys. In 1995, as a visiting scientist at the Israel National Solar Energy Center of the Ben-Gurion University, he started to investigate the growth, structure and photoelectrical properties of fullerene thin films. In 1997, Dr. Katz joined the Ben-Gurion University's Institute for Desert Research and has since been working in the Department for Solar Energy and Environmental Physics. In 2006, he became a member of the Ilse-Katz Center for Meso- and Nanoscale Science and Technology at the Ben-Gurion University. He is reviewer for 15 physical and materials science journals. Dr. Katz's research interests include areas of applied solar energy, photovoltaics based on nontraditional semiconductors (fullerenes, carbon nanotubes, conjugated polymers, etc), photovoltaic characterization of AIII BV concentrator solar cells at ultra-high concentration of natural sunlight (1,000 suns and more), and synthesis of carbon and inorganic fullerenes and

nanotubes by concentrated sunlight. He has published more than 120 scientific papers and book chapters on the above-mentioned topics (including 48 peer-reviewed papers in international journals), and 13 popular articles on fullerene-like structures in carbon nanomaterials, living organisms, and their architectures.



**Kion Norrman** obtained his Ph.D. in physical-organic chemistry from the University of Copenhagen in 1996. His research interests have since shifted from gas-phase ion chemistry using theoretical and mass spectrometry based methods to surface science with focus on modification and characterization of polymer surfaces using a suite of physical and chemical characterization techniques. After having worked one year at the Danish Technological Institute, Dr. Norrman obtained a position at Risø National Laboratory in 1999. His work focused around time-of-flight secondary ion mass spectrometry (TOF-SIMS) and eventually photo-

oxidation of polymer surfaces, which consequently led to collaboration with colleague Frederik Krebs and a lot of fascinating results within the field of degradation of organic solar cells.