| Implant Name Associated Consort | tium Commercial Affiliation | Inventors Devices Sold | d FDA Approval (U.S | S. ، CE Mark (E.U. comm | erci Stimulation Modal | lity Trode Location | ion Implant Locat | tion Image Capture Image Proce | essor location Image Processing | Type Surgical app | roach Other Device Det | ails Overal Statu | s History | Status of animal trials | Registered Clinical Trials | Status, #, dates of human implantations | Trode # Trode ma | aterial Trode Size Tro | de pitch Trode layout Insulation of Trode | Tracks Hermetics | s Wireless? Sur | gery Duratioı SAE rate A | E rate Other Unique Details | Last Update | d Notes |
|--|--|-----------------------------|----------------------|-------------------------|---|---|--|--|--|--|--|--|--|--|--|--|--------------------------------|---------------------------|---|------------------|-----------------|--------------------------|---|---|---|
| Bionic Eye - BrainPort V100 - | - A | | 0 N 0 Yes, June 2015 | N Y, & Hong Kong | Electrical Electrical | Subretinal Epilingual | - removable | External camera - | - - | - | - | Last relevant paper in 2005 | | - | - http://clinicaltrials.gov/ct2/results?term=brainpor | rt - | | | | - - | | | | Rathbun | Photodetectors are based on PbLaZrTiO3 (PLZT) and BiVMnO3 (BVMO) films http://www.wicab.com/ |
| BrainPort V200 - | | | 0 N | N | Electrical | Fnilingual | removahle | mounted in glasses External camera - | <u>-</u> | | | - | _ | _ | &Search=Search | | | | | | | | | | http://www.scientificamerican.com/article/device- lets-blind-see-with-tongues/ |
| | | | | IN | Electrical | Еринідиа | Temovable | mounted in glasses | - | | | - | | | NC102373110 | | | | | - | | | | Rathbun | - |
| Brindley Cortical Implant - Dobelle Cortical Implant - | | - 16 (according to | 0 N 0 Me N | N | Electrical Electrical | Cortical, surfac | | external camera - | - | - | - Surface | - | - | - | - | | 76 or 180 e - 64 or 144? Pt | | | - | | | - | 12.08.2016, Rathbun 12.08.2016, | http://www.artificialvision.com/etumble.htm |
| LICOS/WATCH - | | - | 0 N | N | Electrical | Subretinal | Subretinal | Subretinal - Photodiodes | - | - | LICOS light-controllo | | - | - | - | - | - | 35 x 35 ~75 | | - | | | - | | Mazza M Renaud P Bertrand DC Ionescu AM CMOS pixels for subretinal implantable prosthesis IEEE |
| Microfluidic - | | - | 0 N | N | Chemical | none | Cortical. Retinal | 1 | <u>-</u> | - | intensity wave acro the chip | s | _ | _ | - | - | - | | | - | | | - | | Sensors 2005 Kresge Eye Institute project |
| Neurotransmitter miRI - | | | 0 N | N | Electrical | Epiretinal or | Extraocular | External camera external | - | - | - | Defunct? Little | | - | - | - | - | | | - | | | | Rathbun 12.08.2016, | Gerding seems to have spun off to make this device |
| NeuroPace RNS - | | - | 0 N | N | Electrical | Episcleral?, penetrating Cortical, surfac | ce - | mounted in glasses | - | - | - | recent work. | - | - | NCT02747589 | Clinical trial of 5 patients started in 2016 | - | | | - | | | - | | Use of an epilepsy implant as a visual cortex |
| Argus I (Argus 16) ARP | Second Sight - | - | 0 N | N | Electrical | Epiretinal | Retroauricular | Camera mounted External on glasses | resolution reductio | n - | - | - | - | - | - | Discontinued, 6 from Feb. 2002-2004 | 16 Pt | 500 μm diamet 800 μ | um rectilinear 4 x 4 - | - | Y 3 h | nours | Subdermal cochlear electror case, implanted in 6 patient. | nics 04.05.2016, | stimulator. |
| Argus II ARP | Second Sight - | - | 0 Y, 14.02.2013 | Y, 2011 | Electrical | Epiretinal | intraorbital | Camera mounted External on glasses | resolution reductio | n - | - | Active | - | - | http://clinicaltrials.gov/ct2/results?term=%22secod+sight+medical+products%22&Search=Search NCT01490827, NCT00407602 (feasibility), NCT02303288, NCT02227498, NCT01860092 (post approval study), NCT00279500 | 200. Review. First clinically approved patient implant 29.10.2011. 150 additional patients since | 60 Pt | 200 μm (also 3ι 525 μ | um rectilinear 10 x 6 - | - | Y 3 h | nours | | | http://www.secondsight.com/g-the-argus-ii- prosthesis-system-pf-en.html |
| ASR Artificial Silicon ASR Retina (Optobionics) | | - | 0 N | N | Electrical | Subretinal | Subretinal | Subretinal Subretinal Photodiodes | Minimal | - | - | - | - | - | previous clinical trials | at least 42, First clinical trials with 3 patients getting 3500 MPDA. at least 6 Patients in 2000, 4 later. At least 30 as of Weiland et al. 2011 review First clinical trials with 3 patients getting 3500 MPDA. at least 6 Patients in 2000, 4 later. At leas 30 as of Weiland et al. 2011 review. | | diameter, 25 microns tl - | | - | | | - | 12.08.2016, Rathbun | - |
| Boston Retinal BRIP Prosthesis V1 | | - | 0 N | N | Electrical | Epiretinal | Epiretinal | | - | - | electronics tacked n | | - | - | - | - | | | | - | Y, laser power- | | - | 12.08.2016, Rathbun | - |
| Boston Retinal BRIP Prosthesis V2 | | - | 0 N | N | Electrical | Epiretinal | Intraocular | | - | - | attachment electronics placed in lens capsule, laser | Discontinued | - | - | - | - | | | | - | Y, laser power- | | - | 12.08.2016, Rathbun | - |
| Boston Retinal Prosthesis BRIP V3 | Bionic Eye Technologies 1 Inc. is | 11 patents issued | 0 N | N | Electrical | Subretinal | Subretinal with exiting eye to | cable External Side of eye? | - | ab externo | transmission of pow and data | | - | - | Funded to run pre-clinical trials under FDA's new accelerated program. | at least 6 patients as of 2005, Nov. 9, 2000 FDA approval human testing | 256+ IrOx | 400 - | | Titanium case | e Y - | | - | 01.09.2016, | Kelly SK et al Shire Rizzo Cogan Wyatt The boston retinal prosthesis IEEE 2009.pdf |
| 24ch Prototype BVA Suprachoroidal | Bionic Vision Technologies - | - | 0 N | N | Electrical | Suprachoroidal | extraocular electronics | Camera mounted - on glasses | - | - | - | Phase 1 Clinical | | - | - | - | | | | - | | | - | 06.09.2016, Abbott | - |
| 44ch Fully-Implantable BVA Suprachoroidal | Bionic Vision Technologies - | - | 0 N | N | Electrical | Suprachoroidal | al Retroauricular | Camera mounted - on glasses | - | - | flexible cable | Clinical Trial | | active chronically implanted preclinic | | nic 24ch prototype device: 3 patients implanted in 2012; 44chFl device trial to begin late 2016 | 44 Pt | 125, 160 ~1 m | m Staggered | - | - <4 | hours See Ayton et See | Ayton e Percutaneous plug used in 2 prototype design, this has b removed in the 44ch fully- | | Ayton et al PlosOne 2014; Shivdasani MN Luu CD Cicione R Fallon JB Allen PJ Leuenberger J Suaning GJ Lovell NH Shepherd RK Williams CE Evaluation J |
| Diamond-based BVA epiretinal device | Bionic Vision Technologies - & iBionics | - | 0 N | N | Electrical | Epiretinal | - | Camera mounted - on glasses | - | - | - | Nov. 2016 Active. Currentl early stages of | Technologies Pty Ltd (Australia) y in Bionic Vision Australia (BVA) awarded funding in October 2009, diamond-based epiretinal device developed, es undergone early stages of preclinical testing, now being | - | - | - | 256 Diamond | | <u> </u> | - | | | implantable device | 06.09.2016, Abbott | Neural Eng 2010 |
| Phoenix 99 BVA Suprachoroidal | Bionic Vision Technologies - | - | 0 N | N | Electrical | Suprachoroidal | al Retroauricular | Camera mounted - on glasses | - | - | - | final stages of | further developed and commercialised through iBionics (Canada) y in Bionic Vision Australia (BVA) awarded funding in October 2009, Phoenix 99 Suprachoroidal developed, currently in final stages of preclinical evaluation, Phase 1 Clinical Trial expected 2017, being commercialised through Bionic Vision | studies | - | Phase 1 Clinical Trial expected 2017 | 98 Pt | | Hexagonal PDMS | - | | | - | 06.09.2016, Abbott | - |
| C-Sight C-Sight | - | - | 0 N | N | Electrical | Subretinal or O | Optic - ating | | - | - | Electrical, Optic Ner | ve, - | Technologies Pty Ltd (Australia) | - | - | • | - | | | - | | | http://en.coe.pku.edu.cn/O nding-Talents/56.htm | Outsta 01.08.2016, Rathbun | Chinese Ministry of Science and Technology Under National Key Basic Research |
| EPIRET (1) EPI-RET | - | - | 0 N | N | Electrical | Epiretinal | Epiretinal | | - | - | - | - | - | - | - | 8 patients implanted, 7 subjects implanted as of Weiland et al. 2011 review. | - | | | - | | | - | 12.08.2016, Rathbun | Schanze T Thomas U A fully implantable epiretinal vision prosthesis for retinitis pigmentosa patients Proc Sensor 2009.pdf |
| EPIRET 2 EPI-RET | - | - | O N | N | Electrical | Epiretinal | Intraocular - Epiretinal conne to lens capsule | External camera in glasses ected mounted in glasses | - | - | - | Completed | - | - | http://clinicaltrials.gov/ct2/results?term=%22Intel gent+Medical+Implants+GmbH%22&Search=Searc | | 25 IrOx on gol | ld ~100 | Rectilinear, 5 x 5 parylene-C | - | Υ - | | telemetric system | | BMBF (01KP001, EPI-RET-II) Hungar K Goertz M Slavcheva E Spanier G Weidig C Mokwa W Production processes for a flexible retina implnat Sensors Actuators 2005.pdf |
| EPIRET 3 EPI-RET | - | - | 0 N | N | Electrical | Epiretinal | Lens Capsule | - | - | - | - | - | - | - | DE/CA21/A/07/Dr.SchmidtIOL/EPIRETIII | - | 25 IrOx | 100 | 500 Hexagonal, 5 x 4·- | - | Υ - | | - | | Klauke S Goertz M Rein S Hoebl d Thomas U Eckhorn R Bremmer F Wachtler T Stimulation with a Wireless Intraocular Epiretinal IOVS 2011 |
| OPTOEPIRET EPI-RET | - | - | 0 N | N | Electrical | Epiretinal | Epiretinal | Integrated into Epiretinal chip | - | - | - | Very little information available | - | - | - | - | - | | | - | | | - | 12.08.2016, Rathbun | http://www.egms.de/static/en/meetings/artvis201 5/15artvis34.shtml http://gepris.dfg.de/gepris/projekt/278868304 |
| ICVP Intracortical Visual ICVP Prosthesis | | | 0 N | N | Electrical | Cortical, penetrating | - | | - | - | - | - | - | - | - | - | | | - | | | | | 12.08.2016, Rathbun | - |
| AV-DONE Artificial vision Japan by Direct Optic Nerve electrode | | | 0 N | IN . | Electrical | Optic Nerve He | eau, - | External camera - mounted in glasses | - | - | - | - | - | - | - | | | | | | | | | Fujikado | http://atlasofscience.org/artificial-vision-by-direct- optic-nerve-electrode-av-done/ |
| Biohybrid Japan | | - | 0 N | N | Electrical stimulation cultured neurons | · | - | External camera - mounted in glasses | - | - | - | - | - | - | - | - | | | - | - | | | - | 16.08.2016, Fujikado | - |
| OUReP Japan | - | - | 0 N | N | Electrical (Photoelect dye-coupled polyethylene film) | tric Subretinal | subretinal witho | out subretinal - | Photoelectric Dye | - | - | - | - | - | - | - | | | - | - | | | - | 16.08.2016, Fujikado | - |
| Three Dimensions Japan Stacked Retinal Prosthesis | - | - | 0 N | N | Electrical | Subretinal, (ear | arlier Subretinal with to side of eye, (Earlier Epiretin with cable to Le Capsule) | | Photodiodes and o algorithms | n-chip - | 3D, Stacked | - | - | - | - | - | 100 PEDOT | 90 - | Rectilinear, 10 x - | - | Υ - | | - | 16.08.2016, Fujikado | Every publication seems to present a different version of this implant. Need their help clarifying. Tanaka T et al Sato Komiya Kobayashi Watanabe Fukushima Tomiat Kurino Tamai Koyanagi Fully implantable retinal prosthesis chip with photodetector and stimulus current generator IEEE |
| VPP, Osaka, STS retinal Japan implant | | - | 0 N | N | Electrical | Suprachoroidal (intrascleral) | al Retroauricular | External camera in glasses mounted in glasses | - | extraocular | - | - | - | - | UMIN000012754, https://upload.umin.ac.jp/cgi- open-bin/ctr_e/ctr_view.cgi?recptno=R000014137 | Trial closed. 3 patients implanted in 2014 7 | 49 Pt | 500 700 μ | um Rectilinear, 7 x 7 parylene-C | - | Υ - | | - | 16.08.2016, Fujikado | IEDM 2007.pdf Fujikado T Kamee M Sakaguchi H Kanda H Morimoto T Ikuno Y Nishida K Kishima H Marua T Konoma K Ozawa M Nishida K Testing of semichronically implanted retinal prosthesis IOVS 2011.pdf |
| MGH Thalamic Visual Prosthesis Gennaris bionic vision MGH Thalamic Visual Prosthesis MVG MVG | Bionic Eye Technologies J. Inc. Grey Innovation, MiniFAB - | J. Pezaris | 0 N | N N | Electrical Electrical | Thalamus | - Primary visual c | cortex Camera mounted External | - | - Neurosurgical | | - Active. Preparin | - g Monash Vision Group awarded funding October 2009, | - | | - | up to 473 Pt-Ir | | | | | | | 05.09.2016, Pezaris 14.09.2016, | - |
| system | , | | | | | | · | on glasses | | C | | for first in huma clinical trials | | s | | | · | | | | | | | Pritchard | |
| NanoRetina (NR600) NanoRetina NPP "hat-pin" NPP | NanoRetina - | | 0 N | N | Electrical Electrical | Epiretinal | - | - | - | - | retina penetrating a | | | - | | - | | | - | | | | | 04.09.2016, Hanein 12.08.2016, | http://nano.tau.ac.il/hanein/index.php/projects/funmania Quantum Dot/Carbon Nanotube design. |
| MiVip - Microsystem- OptiVip | | | 0 N | N | Electrical | Optic Nerve | - | | - | - | - | | . MiVip ran from 1996 to 2000. | - | - | 2 Patients, First clinical implantation around 2000 | | | | | | • • | - | Rathbun 12.08.2016, | - |
| based visual prosthesis OptiVip Optic nerve OptiVip visual prosthesis | - | | 0 N | N | Electrical | Optic nerve | - | | - | - | - | - | OptiVip ran from 2000 to 2005. | - | - | - | | | | - | | | - | Rathbun 12.08.2016, Rathbun | - |
| IRIS v1 Pixium | Pixium - | - | O N | N | Electrical | Epiretinal | - | external camera - | - | - | - | - | - | - | http://clinicaltrials.gov/ct2/results?term=%22Intel gent+Medical+Implants+GmbH%22&Search=Searc NCT00427180 pilot by IMI, NCT01864486 by Pixiun | ch m | 49 - | | | - | - | | - | 12.08.2016, Rathbun | - |
| PRIMA Pixium | Pixium - | - | 0 N | Y, 25.07.2016 | Electrical Electrical | Epiretinal Subretinal | - | external camera - | - | - | - | - | - | - | http://clinicaltrials.gov/ct2/results?term=pixium& earch=Search NCT02670980 - | | | | hexagonal - | | | | - | 12.08.2016, Rathbun 12.08.2016, | - preclinical development 08.08.2016 |
| Electronic Visual Cortical Polystim Stimulator (EVCS) | Cortivision M | M. Sawan et al. | 0 N | N | Electrical | Intracortical | Cortical | External camera Connected to g mounted in glasses Ear | glasses close to CMOS Pixel Sensor | s Invasive | Inductive link for po | wer, Prototype unde test | r - | - | Not yet projected | None | Several 3D Pt on Siliciu | um multi 5x5 array | 200 4x4 & 5x5 - | - | Υ - | | Monitoring of implant statu | Rathbun | Hasanuzaman, "A Wireless, High-Voltage Compliant And Energy-Efficient Visual Intracortical |
| Intracortical Visual Polystim | Cortivision | M. Sawan et | 0 N | N | Electrical | Intracortical | Cortical | External camera Connected to g | glasses close to CMOS Pixel Sensor | s Invasive | bidirectionnel data One inductive link f | or Completed, but | - | Rats for stimulation, Monkey for | N/A | None | Several 2D Pt on stainl | less stee 1.5mm tall 50 | 400 4x4 - | - | Υ - | | Monitoring of implant statu | us 13.08.2016, | Microstimulator", Completed PhD Thesis, June 2016 Coulombe, Sawan, Gervais "A Highly Flexible |
| Multiunit Stimulator | a | al. | | | | | | mounted in glasses Ear | 331331 | | both power and bidirectionnel data | does not preser High-voltage compliance | | recording | | | | | | | | | Jp.sirestatu | Sawan | System for Microstimulation of the Visual Cortex: Design and Implementation", IEEE TBioCAS, Vol. 1, No. 4, 2007, pp. 258-269 |
| QuantumRetina QuantumRetina | - | - | 0 N | N | Electrical | Epiretinal | - | Quantum - dots/Photopolyme r | - | - | - | - | - | - | - | - | - | | | - | - | | - | 04.09.2016, Hanein | - |
| Orion I Second Sight | Second Sight - | - | 0 N | N | Electrical | Cortical | - | - | - | - | - | - | - | - | - | - | - | | | - | | | https://www.braininitiative.ov/pdf/Second- | Rathbun | - |
| Seoul Artificial Retina SNU | | - | 0 N | N | Electrical | (Epiretinal or) Suprachoroidal | Suprachoroidal | | - | - | Liquid crystal polym based | er Preclinical testir | ng - | - | prior clinical trials? | none yet | 16 IrOx | | <u> </u> | - | Υ - | | Sight_device_exhibits_9201 8C.pdf - | | Jeong J Bae SH Min KS Seo JM Chung H Kim SJ A miniaturized eye conformable and long term |
| The vOICe The vOICe | - P | P. Meijer currently free fo | or nr - | - | Auditory | penetrating | | external camera smartphone, a | ugmented resolution reductio | n | based | Available as app | ns - | | _ | several hundred thousand app installs worldwide | 176v64 > 40 000 | | | | | | non invesive | | reliable retinal prosthesis IEEE Trans BME 2015.pdf http://www.seeingwithsound.com, |
| The voice | - ** | P. Meijer currently free to | OF TIC- | - | Auditory | - | - | reality glasses, | or wearable image enhancement ry Pi version is image to sound con | nt and | - | for Android, Microsof Windo and as a WebRT web app. (A Raspberry Pi version is availa from After Sight | bws, CC | - | | by blind & sighted users (>quarter million for Android version) | 176x64 > 10,000 | - | - | - | | | non-invasive | | http://www.seeingwithsound.com/ http://www.after-sight.com |
| Alpha-AMS Tübingen | Retina Implant, GmbH - | - 1, 5 pending as o | of 1 N | Y | Electrical | Subretinal | Retroauricular | Subretinal | Photodiodes | ab externo | - | | <u>-</u> | - | NCT01024803, NCT02720640 | active, 16 as of 11.08.2016, 8 in Tübingen, 5 in Oxford, 2 in Dresden, 2 in Kiel | 1600 TiN | 50 x 50 70 μr | m rectilinear 40 x 4 polyimide | ceramic | Y 4.5 | 5-8 hours | - | 11.08.2016, Zrenner/Rathl | - ou |
| Alpha-IMS Tübingen | Retina Implant, GmbH - | - | 0 N | Υ | Electrical | Subretinal | Retroauricular | - Subretinal | Photodiodes | ab externo | - | discontinued | - | - | http://clinicaltrials.gov/ct2/results?term=%22retin +implant+AG%22&Search=Search NCT01024803, NCT02588430, NCT01497379 (Hong Kong | na discontinued | 1600 TiN | 50 x 50 70 μm | m rectilinear 40 x 4 polyimide | ceramic | Υ - | See Kitiratsc - | - | n 11.08.2016, Zrenner/Rathb n | - |
| MPDA Tübingen | none - | - | 0 N | N | Electrical | Subretinal | none | - Subretinal | Photodiodes | ab externo | unamplified photodiodes, 3 mm diameter, 50 μm th | | - | ab externo, ab interno tried in pig | collaborator) - | none | 7600 TiN | 8 x 8 ~40 μ | um rectilinear, disk polyimide | - | Υ - | | - | Zrenner/Rathl | Zrenner E The subretinal implant can nu microphotodiode arrays replace degenerated retinal photoreceptors to restore vision Ophthalmologica 2002.pdf Iridium, Gold, Pt were |
| MPDA2 Tübingen | Retina Implant, GmbH - | - | 0 N | N | Electrical | Subretinal | none | - Subretinal | Photodiodes | ab externo | IR power supply to provide amplification PD array. | | - | - | - | none | 12-? TiN | 20 x 20 | rectilinear polyimide | - | γ - | | - | Zrenner/Rathl | also tried during early development. Sailer H Shinoda K Blatsios G Kohler K Bondzio L Trenner E Gekeler F Investigation of thermal effects of infrared lasers Graefes Arch Clin Exp Ophthalmol 2007.pdf |
| Tübingen Prototype Tübingen | Retina Implant, GmbH - | | 0 N | N | Electrical | Subretinal | transdermal | - Subretinal | Photodiodes | ab externo | - | discontinued | - | - | NCT00515814 | discontinued, 29, includes Tuebingen Hong Kong and Singapore | | 50 x 50 70 μm | | - | | | | Zrenner/Rathb n | BMBF, grant no 01KP0401) nu |
| CORTIVIS UIEA Utah Cortical Prosthesis, UIEA | | | 0 N | N | Electrical | Cortical, Cortical. | intracortical, subdermal | Bioinspired - artificial retina, camera mounted on glasses | bioinspired encode | standard neurosurgical procedure | ny, Includes a bioinspir visual encoder | d Active. Developing, Clinical trials 20 | - 16- - | - | - | Human trials planned for early 2017. 12 subjects implanted for preclinical studies (Fernandez&Normann,2017) | | atiunum 10 x 10 400 μ | | - | | 2 hour | | Rathbun | http://cortivis.umh.es/ |
| Utah Cortical Prosthesis, UIEA Utah Intracortical Electrode Array (UIEA) VISNE: VISual neuroprosthesis based | | - | 0 N | N | Electrical | Cortical, penetrating Thalamic, penetrating | Thalamus | external camera external device | e minimal | invasive | - | lab prototype | - | Ongoing - rats and rabbits | - | - | - 24 tungsten | 4x6 arrays - | | | in the future - | | | 12.08.2016, Rathbun 10.09.2016, Panetsos | - |
| neuroprosthesis based on adaptive Neuron- silicon interfaces | | | | | | penetrating | | | | | | | | | | | | | | | | | | ranetsos | |