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## Introduction

- The smart drug delivery system is used for delivering drugs to the host. Biological information detected by biological sensors is analyzed and the drug delivery system is actuated to deliver the drug based on the information.
- The system utilizes MEMS or NEMS technology based drug pumps, micro-pumps, micro-needles, micro-osmotic pumps, and nano-pumps.
- MEMS based drug delivery systems provide enhanced drug therapy which allows accurate dosing with more efficacy and effectiveness. The application of MEMS for drug delivery through biocapsules, microneedles, and micropumps offers a less invasive drug therapy and improves the quality of life of the patients.
- It also includes sensors or communication systems to remotely activate or control the pumps.

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## Smart Drug Delivery Systems: Search Strategy

### Control Patents

| S. No. | Patent/Publication No.        | Publication Date (mm/dd/yyyy) | Assignee / Applicant                | Title   |
|--------|-------------------------------|-------------------------------|-------------------------------------|---|
| 1      | <a href="#">US6723086</a>     | 04/20/04                      | Logiq Wireless Solutions            | Remote controlled transdermal medication delivery device  |
| 2      | <a href="#">US20070071596</a> | 03/29/07                      | Sensile PatAG                       | Liquid drug delivery micropump  |
| 3      | <a href="#">US20060283465</a> | 12/21/06                      | Hewlett-Packard Development Company | Smart drug delivery system and a method of implementation thereof                                     |
| 4      | <a href="#">US20050187515</a> | 08/25/05                      | Advanced Neuromodulation Systems    | Reduced size programmable drug pump   |
| 5      | <a href="#">US20040220498</a> | 11/04/04                      | None                                | Micro medical-lab-on-a-chip in a lollipop as a drug delivery device and/or a health monitoring device |
| 6      | <a href="#">US20060271020</a> | 11/30/06                      | Chrono Therapeutics                 | Portable drug delivery device including a detachable and replaceable administration or dosing element |
| 7      | <a href="#">US20080161779</a> | 07/03/08                      | None                                | Implantable nano pump for drug delivery   |

### Concept Table

| S. No. | Concept 1                      | Concept 2                     | Concept 3      | Concept 4         | Concept 5 |
|--------|--------------------------------|-------------------------------|----------------|-------------------|-----------|
|        | MEMS                           | NEMS                          | Drug           | Communication     | Delivery  |
| 1      | microelectromechanical Systems | nanoelectromechanical systems | pharmaceutical | telemetry         | inject*4  |
| 2      | microsystem Technology         | bioNems                       | medicament     | wireless          | perfus*3  |
| 3      | bioMems                        | nanopump                      | medicin*4      | remote monitoring | infus*3   |
| 4      | micropump                      |                               | medicat*4      | programmable      | diffus*3  |
| 5      | microneedle                    |                               | medicant*1     | self-actuated     | releas*   |
| 6      | microosmotic pump              |                               | therapeutic*   | automated         | administ* |
| 7      | lab on a chip                  |                               |                | timed             | dispens*  |
| 8      | lab micro chip                 |                               |                |                   |           |

### English Keyword Search

Database: **MicroPatent**  
 Timeline: **01/01/1991 - 01/01/2011**  
 Patent Coverage: **USG, USA, EP-A, EP-B, WO, JP, DE,GB, FR**

| S. No. | Concept     | Search Query   | Scope                      | Hits   |
|--------|-------------|--|----------------------------|--------|
| 1      | MEMS + NEMS | microelectromechanical OR (micro ADJ2 electro ADJ2 mechanical) OR mems OR nems OR nanoelectromechanical OR (nano ADJ2 electro ADJ2 mechanical) OR micropump*1 OR (micro ADJ2 pump*1) OR (biomems) OR (bio ADJ2 mems) OR bionems OR (bio ADJ2 nems) OR (nano ADJ2 pump*1) OR nanopump*1 OR ("microosmotic pump*1") OR (micro ADJ2 osmotic ADJ2 pump*1) OR ("lab on chip") | claims, title, or abstract | 27,867 |

|   |                      |  |                            |                  |
|---|----------------------|--|----------------------------|------------------|
|   |                      | OR ("lab on a chip") OR (lab ADJ2 on ADJ2 chip) OR (lab ADJ2 on ADJ2 a ADJ2 chip) OR ("lab micro chip") OR (lab ADJ2 micro ADJ2 chip) OR ("microsystem technology") OR ("microsystem technologies") OR (micro ADJ2 system ADJ2 tech*) OR (microneedle*1) OR (micro ADJ2 needle*1)  |                            |                  |
| 2 | Drug Delivery        | (drug*1 OR pharmaceutic*3 OR pharma OR medicin*4 OR medicament*1 OR medicat*4 OR medicant*1 OR (medical ADJ3 substance*1) OR therapeutic*4) NEAR10 (deliver*3 OR inject*4 OR perfus*3 OR infus*3 OR diffus*3 OR releas*3 OR administ* OR dispens*)   | full spec                  | 6,52,748         |
| 3 | Sensor/Communication | wireless OR (wire ADJ2 less) OR telemetr*6 OR ((sens*3 OR sensor*1 OR (radio ADJ2 frequenc*3)) SAME (transmit*4 OR transmission OR communicat*3 OR transfer*3 )) OR (rf ADJ2 (transmit*4 OR transmission)) OR ((communicat*3 OR transfer*3 OR transmit*4 OR transmission) SAME (signal*1 OR data OR information*1)) OR *programmed OR *programming OR *program?er OR *programmable OR automated OR *timed OR *timing OR *timer OR ((self OR auto) ADJ2 regulat*) OR ((self OR auto) ADJ2 sustain*3) OR ((self OR auto) ADJ2 actuat*3) OR ((control*3 ADJ2 (system*1 OR device*1 OR unit)) SAME (remote*2 OR transmit*4 OR transmission OR transfer*3)) | claims, title, or abstract | 26,46,253        |
| 4 | Final Query          | 1 AND 2 AND 3  | -                          | 552 (278 unique) |

## German Keyword Search

| S. No. | Concept              | Search Query   | Scope                      | Hits     |
|--------|----------------------|--|----------------------------|----------|
| 1      | MEMS + NEMS          | mikroelektromechanische OR (mikro ADJ2 electro ADJ2 mechani*) OR mems OR nems OR nanoélectromécáni* OR (nano ADJ2 electro ADJ2 mechani*) OR micropompes OR (micro ADJ2 pompes) OR (micro ADJ2 fluídique*1) OR microfluidique*1 OR biomems OR (bio ADJ2 mems) OR bionems OR (bio ADJ2 nems) OR (nano ADJ2 pompe*1) (nanopompe*1) OR (?microosmotique pompe*1?) OR (micro ADJ2 osmotique pompe*1) OR (?labor auf dem chip?) OR (labor ADJ2 auf ADJ2 dem ADJ2 chip ) OR (?lab mikrochip?) OR (lab ADJ2 mikrochip) OR (lab ADJ2 mikro ADJ2 chip) OR (?mikrosystem technologie?) OR (?mikrosystem technologien?) OR ( mikro ADJ2 system ADJ2 technologie) OR (mikro ADJ2 system ADJ2 technologien) OR ( mikrosystem ADJ2 technologie) OR ( mikrosystem ADJ2 technologien) OR mikronadel   | claims, title, or abstract | 24,112   |
| 2      | Drug Delivery        | (drug OR Pharmazeutische*1 OR pharma OR Medizin OR Medikation OR Medikament OR therapeutischen OR Therapeutik OR (medizinische ADJ2 Substanz*2)) NEAR10 (Liefere OR Lieferung OR Delivering OR injizieren OR Einspritzen OR Injektion OR perfuse OR perfusion OR einflößen OR infusion OR diffusen OR diffusion OR diffundierenden OR Freigabe OR Loslassen OR verwalten OR Verwaltung OR verzichten OR Dosierung)   | full spec                  | 43,825   |
| 3      | Sensor/Communication | drahtlos OR wireless OR (wire ADJ2 less) OR telemetrie OR fernmessung OR ((abfragung OR sensor OR (radio ADJ2 frequenz*2)) same (übertragung OR kommunizieren OR kommunikation)) OR (rf ADJ2 übertragung) OR ((kommunizieren OR kommunikation OR übertragung) same (signal OR daten OR informationen)) OR *programmiert OR *programmierung OR zeitgesteuert OR *timer OR *timing OR ((selbst OR auto) ADJ2 (regulieren OR regeln OR geregelt OR reguliert OR regulieren OR regulierung)) OR ((selbst OR auto) ADJ2 nachhaltig) OR ((selbst OR auto) ADJ2 (betätigen OR betätigt))  | claims, title, or abstract | 7,43,303 |
| 4      | Inventors            | (aceti NEAR4 john NEAR4 gregory) OR (bachman NEAR4 mark) OR (bardell NEAR4 ronald NEAR4 louis) OR (bassuk NEAR4 william ) OR (birdwell NEAR4 vince ) OR (bui NEAR4 tuan) OR (cabus NEAR4 eugen) OR (cates NEAR4 adam ) OR (chau NEAR4 qui) OR (dipierro NEAR4 guy) OR (erickson NEAR4 john) OR (etheredge NEAR4 robert ) OR (fein NEAR4 seymour) OR (friden NEAR4 phillip ) OR (gates NEAR4 iii NEAR4 william ) OR (giampapa NEAR4 vincent ) OR (giannos NEAR4 steven ) OR (goldberg NEAR4 dennis ) OR (goode NEAR4 paul ) OR (gregory NEAR4 christopher NEAR4 carter) OR (hartwell NEAR4 peter) OR (herbst NEAR4 ewa) OR (herschkowitz NEAR4 samuel) OR (heruth NEAR4 kenneth ) OR (holmes NEAR4 elizabeth ) OR (howard NEAR4 john) OR (huang NEAR4 joseph) OR (hughes NEAR4 ralph ) OR (hyde NEAR4 roderick ) OR (jacobson NEAR4 stephen ) OR (jacobson NEAR4 james ) OR (jandrisits NEAR4 alice) OR (kane NEAR4 david) OR (kowalik NEAR4 francis ) OR (lal NEAR4 biren) OR (larson NEAR4 lary ) OR (lee NEAR4 abraham NEAR4 phillip) OR (li NEAR4 guann NEAR4 pyng) OR (martin NEAR4 francis) OR (mattes NEAR4 michael ) OR (mazar NEAR4 scott ) OR (mcbride NEAR4 sterling NEAR4 eduard) OR (moroney NEAR4 iii NEAR4 richard NEAR4 morgan) OR (naamat NEAR4 judy ) OR (nason NEAR4 clyde ) OR (nickel NEAR4 janice) OR (nielsen NEAR4 ole NEAR4 christian) OR (ozeri NEAR4 jehonatan) OR (ozeri NEAR4 shaul) OR (petersen NEAR4 john ) OR (preuthun NEAR4 jan NEAR4 harald) OR (radmer NEAR4 jim) OR (rebec NEAR4 mihailo ) OR (roy NEAR4 shaunak) OR (rush NEAR4 benjamin) OR (ryser NEAR4 peter) OR (schwichtenberg NEAR4 jay NEAR4 gordon) OR (solomon NEAR4 neal) OR (straessler NEAR4 sigrid) OR (stutz NEAR4 jr. NEAR4 william ) OR (tegreene NEAR4 clarence ) OR (thompson NEAR4 david ) OR (trovato NEAR4 karen ) OR (varrichio NEAR4 anthony) OR (walczak NEAR4 robbie ) OR (wang NEAR4 chengwang) OR (wang NEAR4 tzu-yu) OR (wei NEAR4 chiming) OR (williamson NEAR4 mark) OR (wood NEAR4 jr. NEAR4 lowell ) OR (yap NEAR4 darren ) OR (zanzucchi NEAR4 peter NEAR4 john) OR (zentner NEAR4 gaylen ) OR (zhang NEAR4 sean) | full spec                  | 11,320   |
| 5      | Assignees            | (abbott diabetes care ) OR (rosedale medical inc) OR (arete associate*1) OR (sarcos lc) OR (novo nORDisk as) OR (searete llc) OR (honeywell int inc) OR (serenity pharmaceutical*) OR (transp pharmaceutical*) OR (sensile pat ag ) OR (hewlett-packard development company) OR (hp development company ) OR (chrono therapeutic*) OR (innovations holding*) OR (advanced neuromodulation) OR (baxter international ) OR (logiq wireless solutions) OR (koninklijke philips electronics) OR (bayer healthcare llc) OR  | full spec                  | 1,68,139 |

|   |                |   |   |                |
|---|----------------|---|---|----------------|
|   |                | (medtronic) OR (theranos inc.) OR (cardiac pacemakers ) |   |                |
| 6 | Combined Query | 1 AND 2 AND 3   | - | 29             |
| 7 | Combined Query | 4 AND 6   | - | 15             |
| 8 | Combined Query | 5 AND 6   | - | 13             |
| 9 | Final Query    | 6 OR 7 OR 8   | - | 29 (13 unique) |

## French Keyword Search

| S. No. | Concept              | Search Query  | Scope                      | Hits      |
|--------|----------------------|---|----------------------------|-----------|
| 1      | MEMS + NEMS          | microélectromécanique OR (micro ADJ2 électro ADJ2 mécanique) OR mems OR nems OR nanoélectromécaniques OR (nano ADJ2 électro ADJ2 mécaniques) OR micropompe*1 OR (micro ADJ2 pompe*1) OR microfluidique OR (micro ADJ2 fluide) OR biomems OR (bio ADJ2 mems) OR bionems OR (bio ADJ2 nems) OR nanopompe*1 OR (nano ADJ2 pompe*1) OR (?microosmotique pompe*1) OR ( micro ADJ2 osmotique ADJ2 pompe*1) OR (?laboratoire sur puce?) OR (laboratoire ADJ2 sur ADJ2 puce) OR (?lab micro puce?) OR (lab ADJ2 micro ADJ2 puce) OR (?système de micro technologie?) OR (?système de micro technologies?) OR (système ADJ2 de ADJ2 micro ADJ2 technologie*1) OR (?microsystème technologie?) OR (?microsystème technologies?) OR (microsystème ADJ2 technologie) OR (microsystème ADJ2 technologies) OR (microneedle OR microaiguille)  | claims, title, or abstract | 25,297    |
| 2      | Drug Delivery        | (drogue*1 OR pharmaceutiques OR pharma OR (la médecine) OR (lamédecine) OR (la ADJ2 médecine) OR médicaments OR ((médicaux OR medical) ADJ2 (substance*1)) OR thérapeutique*1) near10 (livraison OR livraison OR (la livraison) OR (la ADJ2 livraison) (lalivraison) OR injectez OR injection OR perfuser OR perfusion OR infuser OR infusion OR diffuse OR administrer OR l?administration OR dispenser OR (?de distribution?) OR (de ADJ2 distribution) OR (dedistribution))  | full spec                  | 18,285    |
| 3      | Sensor/Communication | (sans fil) OR (sans ADJ2 fil) OR wireless OR (wire ADJ2 less) OR télémetrie OR ((capteur OR sensor OR (de détection) OR (de ADJ2 détection) OR détection OR (radio ADJ2 fréquence*1)) same (transmettre OR transmettant OR transmettez OR transmission OR communique*1 OR (la communication) OR (la ADJ2 communication) OR communication)) OR (rf ADJ2 (transmettre OR transmettant OR transmettez OR transmission)) OR ((transmettre OR transmettant OR transmettez OR transmission OR communique*1 OR (la communication) OR (la ADJ2 communication) OR communication) SAME (signal OR données OR (l?information) OR (l ADJ2 information))) OR programmé OR programmation OR temporisé OR minuterie OR temporisateur OR ((auto OR automatique) ADJ2 régler) OR ((auto OR automatique) ADJ2 ( actionner OR actionné))   | claims, title, or abstract | 10,35,863 |
| 4      | Inventors            | (aceti NEAR4 john NEAR4 gregory) OR (bachman NEAR4 mark) OR (bardell NEAR4 ronald NEAR4 louis) OR (bassuk NEAR4 william ) OR (birdwell NEAR4 vince ) OR (bui NEAR4 tuan) OR (cabus NEAR4 eugen) OR (cates NEAR4 adam) OR (chau NEAR4 qui) OR (dipiirro NEAR4 guy) OR (erickson NEAR4 john) OR (etheredge NEAR4 robert ) OR (fein NEAR4 seymour) OR (friden NEAR4 phillip ) OR (gates NEAR4 iii NEAR4 william ) OR (giampapa NEAR4 vincent ) OR (giannos NEAR4 steven ) OR (goldberg NEAR4 dennis ) OR (goode NEAR4 paul ) OR (gregory NEAR4 christopher NEAR4 carter) OR (hartwell NEAR4 peter) OR (herbst NEAR4 ewa) OR (herschkowitz NEAR4 samuel) OR (heruth NEAR4 kenneth ) OR (holmes NEAR4 elizabeth ) OR (howard NEAR4 john) OR (huang NEAR4 joseph) OR (hughes NEAR4 ralph ) OR (hyde NEAR4 roderick ) OR (jacobsen NEAR4 stephen ) OR (jacobson NEAR4 james ) OR (jandrisits NEAR4 alice) OR (kane NEAR4 david) OR (kowalik NEAR4 francis ) OR (lal NEAR4 biren) OR (larson NEAR4 lary ) OR (lee NEAR4 abraham NEAR4 phillip) OR (li NEAR4 guann NEAR4 pyng) OR (martin NEAR4 francis) OR (mattes NEAR4 michael ) OR (mazar NEAR4 scott ) OR (mcbride NEAR4 sterling NEAR4 eduard) OR (moroney NEAR4 iii NEAR4 richard NEAR4 morgan) OR (naamat NEAR4 judy ) OR (nason NEAR4 clyde ) OR (nickel NEAR4 janice) OR (nielsen NEAR4 ole NEAR4 christian) OR (ozeri NEAR4 jehonatan) OR (ozeri NEAR4 shaul) OR (petersen NEAR4 john ) OR (preuthun NEAR4 jan NEAR4 harald) OR (radmer NEAR4 jim) OR (rebec NEAR4 mihailo ) OR (roy NEAR4 shaunak) OR (rush NEAR4 benjamin) OR (ryser NEAR4 peter) OR (schwichtenberg NEAR4 jay NEAR4 gordon) OR (solomon NEAR4 neal) OR (straessler NEAR4 sigrid) OR (stutz NEAR4 jr. NEAR4 william ) OR (tegreene NEAR4 clarence ) OR (thompson NEAR4 david ) OR (trovato NEAR4 karen ) OR (varrichio NEAR4 anthony) OR (walczak NEAR4 robbie ) OR (wang NEAR4 chengwang) OR (wang NEAR4 tzu-yu) OR (wei NEAR4 chiming) OR (williamson NEAR4 mark) OR (wood NEAR4 jr. NEAR4 lowell ) OR (yap NEAR4 darren ) OR (zanzucchi NEAR4 peter NEAR4 john) OR (zentner NEAR4 gaylen ) OR (zhang NEAR4 sean) | full spec                  | 11,320    |
| 5      | Assignees            | (abbott diabetes care ) OR (rosedale medical inc) OR (arete associate*1) OR (sarcos lc) OR (novo nORDisk as) OR (searete llc) OR (honeywell int inc) OR (serenity pharmaceutical*) OR (transp pharmaceutical*) OR (sensile pat ag ) OR (hewlett-packard development company) OR (hp development company ) OR (chrono therapeutic*) OR (innovations holding*) OR (advanced neuromodulation) OR (baxter international ) OR (logiq wireless solutions) OR (koninklijke philips electronics) OR (bayer healthcare llc) OR (medtronic) OR (theranos inc.) OR (cardiac pacemakers )   | full spec                  | 1,68,139  |
| 6      | Combined Query       | 1 AND 2 AND 3   |                            | 13        |
| 7      | Combined Query       | 4 AND 6   |                            | 4         |

|   |                |             |               |
|---|----------------|-------------|---------------|
| 8 | Combined Query | 5 AND 6     | 8             |
| 9 | Final Query    | 6 OR 7 OR 8 | 13 (5 unique) |

## Assignee Search

| S. No. | Concept              | Search Query   | Scope                      | Hits            |
|--------|----------------------|--|----------------------------|-----------------|
| 1      | MEMS + NEMS          | microelectromechanical OR (micro ADJ2 electro ADJ2 mechanical) OR mems OR nems OR nanoelectromechanical OR (nano ADJ2 electro ADJ2 mechanical) OR micropump*1 OR (micro ADJ2 pump*1) OR (biomems) OR (bio ADJ2 mems) OR bionems OR (bio ADJ2 nems) OR (nano ADJ2 pump*1) OR nanopump*1 OR ("microosmotic pump*1") OR (micro ADJ2 osmotic ADJ2 pump*1) OR ("lab on chip") OR ("lab on a chip") OR (lab ADJ2 on ADJ2 chip) OR (lab ADJ2 on ADJ2 a ADJ2 chip) OR ("lab micro chip") OR (lab ADJ2 micro ADJ2 chip) OR ("microsystem technology") OR ("microsystem technologies") OR (micro ADJ2 system ADJ2 tech*) OR (microneedle*1) OR (micro ADJ2 needle*1) | claims, title, or abstract | 27,867          |
| 2      | Drug Delivery        | (drug*1 OR pharmaceutic*3 OR pharma OR medicin*4 OR medicament*1 OR medicat*4 OR medicant*1 OR (medical ADJ3 substance*1) OR therapeutic*4) NEAR10 (deliver*3 OR inject*4 OR perfus*3 OR infus*3 OR diffus*3 OR releas*3 OR administ* OR dispens*)   | full spec                  | 6,52,748        |
| 3      | Sensor/Communication | wireless OR (wire ADJ2 less) OR telemetr*6 OR ((sens*3 OR sensor*1 OR (radio ADJ2 frequenc*3)) SAME (transmit*4 OR transmission OR communicat*3 OR transfer*3 )) OR (rf ADJ2 (transmit*4 OR transmission)) OR ((communicat*3 OR transfer*3 OR transmit*4 OR transmission) SAME (signal*1 OR data OR information*1)) OR *programmed OR *programming OR *program?er OR *programmable OR automated OR *timed OR *timing OR *timer OR ((self OR auto) ADJ2 regulat*) OR ((self OR auto) ADJ2 sustain*3) OR ((self OR auto) ADJ2 actuat*3) OR ((control*3 ADJ2 (system*1 OR device*1 OR unit)) SAME (remote*2 OR transmit*4 OR transmission OR transfer*3))     | claims, title, or abstract | 26,46,253       |
| 4      | Assignee             | (abbott diabetes care ) OR (rosedale medical inc) OR (arete associate*1) OR (sarcos lc) OR (novo nORdisk as) OR (searete llc) OR (honeywell int inc) OR (serenity pharmaceutical*) OR (transp pharmaceutical*) OR (sensile pat ag ) OR (hewlett-packard development company) OR (hp development company ) OR (chrono therapeutic*) OR (innovations holding*) OR (advanced neuromodulation) OR (baxter international ) OR (logiq wireless solutions) OR (koninklijke philips electronics) OR (bayer healthcare llc) OR (medtronic) OR (theranos inc.) OR (cardiac pacemakers )  | full spec                  | 1,68,139        |
| 5      | Final Query          | 1 AND 2 AND 3 AND 4  | -                          | 117 (54 unique) |

## Inventor Search

| S. No. | Concept              | Search Query   | Scope                      | Hits      |
|--------|----------------------|--|----------------------------|-----------|
| 1      | MEMS + NEMS          | microelectromechanical OR (micro ADJ2 electro ADJ2 mechanical) OR mems OR nems OR nanoelectromechanical OR (nano ADJ2 electro ADJ2 mechanical) OR micropump*1 OR (micro ADJ2 pump*1) OR (biomems) OR (bio ADJ2 mems) OR bionems OR (bio ADJ2 nems) OR (nano ADJ2 pump*1) OR nanopump*1 OR ("microosmotic pump*1") OR (micro ADJ2 osmotic ADJ2 pump*1) OR ("lab on chip") OR ("lab on a chip") OR (lab ADJ2 on ADJ2 chip) OR (lab ADJ2 on ADJ2 a ADJ2 chip) OR ("lab micro chip") OR (lab ADJ2 micro ADJ2 chip) OR ("microsystem technology") OR ("microsystem technologies") OR (micro ADJ2 system ADJ2 tech*) OR (microneedle*1) OR (micro ADJ2 needle*1)   | claims, title, or abstract | 27,867    |
| 2      | Drug Delivery        | (drug*1 OR pharmaceutic*3 OR pharma OR medicin*4 OR medicament*1 OR medicat*4 OR medicant*1 OR (medical ADJ3 substance*1) OR therapeutic*4) NEAR10 (deliver*3 OR inject*4 OR perfus*3 OR infus*3 OR diffus*3 OR releas*3 OR administ* OR dispens*)   | full spec                  | 6,52,748  |
| 3      | Sensor/Communication | wireless OR (wire ADJ2 less) OR telemetr*6 OR ((sens*3 OR sensor*1 OR (radio ADJ2 frequenc*3)) SAME (transmit*4 OR transmission OR communicat*3 OR transfer*3 )) OR (rf ADJ2 (transmit*4 OR transmission)) OR ((communicat*3 OR transfer*3 OR transmit*4 OR transmission) SAME (signal*1 OR data OR information*1)) OR *programmed OR *programming OR *program?er OR *programmable OR automated OR *timed OR *timing OR *timer OR ((self OR auto) ADJ2 regulat*) OR ((self OR auto) ADJ2 sustain*3) OR ((self OR auto) ADJ2 actuat*3) OR ((control*3 ADJ2 (system*1 OR device*1 OR unit)) SAME (remote*2 OR transmit*4 OR transmission OR transfer*3))   | claims, title, or abstract | 26,46,253 |
| 4      | Inventors            | (aceti NEAR4 john NEAR4 gregory) OR (bachman NEAR4 mark) OR (bardell NEAR4 ronald NEAR4 louis) OR (bassuk NEAR4 william ) OR (birdwell NEAR4 vince ) OR (bui NEAR4 tuan) OR (cabus NEAR4 eugen) OR (cates NEAR4 adam ) OR (chau NEAR4 qui) OR (dipierno NEAR4 guy) OR (erickson NEAR4 john) OR (etheredge NEAR4 robert ) OR (fein NEAR4 seymour) OR (friden NEAR4 phillip ) OR (gates NEAR4 iii NEAR4 william ) OR (giampapa NEAR4 vincent ) OR (giannos NEAR4 steven ) OR (goldberg NEAR4 dennis ) OR (goode NEAR4 paul ) OR (gregory NEAR4 christopher NEAR4 carter) OR (hartwell NEAR4 peter) OR (herbst NEAR4 ewa) OR (herschkowitz NEAR4 samuel) OR (heruth NEAR4 kenneth ) OR (holmes NEAR4 elizabeth ) OR (howard NEAR4 john) OR (huang NEAR4 joseph) OR (hughes NEAR4 ralph ) OR (hyde NEAR4 roderick ) OR (jacobsen NEAR4 stephen ) OR (jacobson NEAR4 james ) OR (jandrisits NEAR4 alic) OR (kane NEAR4 david) OR (kowalik NEAR4 francis ) OR (lal NEAR4 | full spec                  | 11,320    |



|   |             |  |   |                 |
|---|-------------|--|---|-----------------|
|   |             | biren) OR (larson NEAR4 lary ) OR (lee NEAR4 abraham NEAR4 phillip) OR (li NEAR4 guann NEAR4 pyng) OR (martin NEAR4 francis) OR (mattes NEAR4 michael ) OR (mazar NEAR4 scott ) OR (mcbride NEAR4 sterling NEAR4 eduard) OR (moroney NEAR4 iii NEAR4 richard NEAR4 morgan) OR (naamat NEAR4 judy ) OR (nason NEAR4 clyde ) OR (nickel NEAR4 janice) OR (nielsen NEAR4 ole NEAR4 christian) OR (ozeri NEAR4 jehonatan) OR (ozeri NEAR4 shaul) OR (petersen NEAR4 john ) OR (preuthun NEAR4 jan NEAR4 harald) OR (radmer NEAR4 jim) OR (rebec NEAR4 mihailo ) OR (roy NEAR4 shaunak) OR (rush NEAR4 benjamin) OR (ryser NEAR4 peter) OR (schwichtenberg NEAR4 jay NEAR4 gordon) OR (solomon NEAR4 Neal) OR (straessler NEAR4 sigrid) OR (stutz NEAR4 jr. NEAR4 william ) OR (tegreene NEAR4 clarence ) OR (thompson NEAR4 david ) OR (trovato NEAR4 karen ) OR (varrichio NEAR4 anthony) OR (walczak NEAR4 robbie ) OR (wang NEAR4 chengwang) OR (wang NEAR4 tzu-yu) OR (wei NEAR4 chiming) OR (williamson NEAR4 mark) OR (wood NEAR4 jr. NEAR4 lowell ) OR (yap NEAR4 darren ) OR (zanzucchi NEAR4 peter NEAR4 john) OR (zentner NEAR4 gaylen ) OR (zhang NEAR4 sean) |   |                 |
| 5 | Final Query | 1 AND 2 AND 3 AND 4  | - | 142 (54 unique) |

## Japanese Patent Search

Database: PAJ  
Timeline: 01/01/1991 - 01/01/2011

• F-Term

| S. No. | Theme  | F-term | F-term Definition   |
|--------|--|--------|---------------------|
| 1      | 3C081 - Micro-structural systems ; Micro-electro-mechanical systems (MEMS) | EA29   | Biochips            |
|        |  | EA31   | Fluid apparatus     |
|        |  | EA32   | Micropumps          |
|        |  | EA33   | Micro valves        |
|        |  | EA39   | Medical instruments |

• Search Query

| S.No | Issue/Publication Date  | F-Term Theme | FI/F-term/Facet            | Hits |
|------|-------------------------|--------------|----------------------------|------|
| 1    | 01/01/1991 - 01/01/2011 | 3C081        | [EA32+EA29+EA31+EA33]*EA39 | 22   |

## Article Search

Database : Google Scholar  
Timeline: 01/01/1991 - 01/01/2011

| S. No | Concept              | Search Query  | Hits     |
|-------|----------------------|---|----------|
| 1     | MEMS + NEMS          | (micro-electro-mechanical OR mems OR micropump* OR nanopump* OR nems OR nano-electro-mechanical OR microneedle* OR lab on chip) | 26,100   |
| 2     | Drug Delivery        | ((drug* OR pharmaceutic*) AND (delivery OR administ* OR infus* OR dispens*))  | 8,96,000 |
| 3     | Sensor/Communication | (wireless OR (radio frequency) OR telemetry OR *program*)   | 9,86,000 |
| 4     | Combined Query       | 1 AND 2 AND 3   | 997      |

## Taxonomy

Smart Drug Delivery Systems.mm

Flash plugin or Javascript are turned off. Activate both and reload to view the mindmap

## Sample Patent Analysis

| S. No. | Patent/Publication No.    | Publication Date (mm/dd/yyyy) | Assignee / Applicant     | Title   | Dolcera Summary   |  |
|--------|---------------------------|-------------------------------|--------------------------|---|---|--|
|        |                           |                               |                          |   | Problem   | Solution   |
| 1      | <a href="#">US6723086</a> | 04/20/04                      | Logiq Wireless Solutions | Remote controlled trans-dermal medication delivery device | Ambulatory individuals requiring long term medication need to take medications at | Transdermal medication delivery provides constant and continuous absorption of the drug while allowing the patient to remain |

|   |                               |          |                                 |   |  |  |
|---|-------------------------------|----------|---------------------------------|---|--|--|
|   |                               |          |                                 |   | inconvenient times, in awkward locations, or have to stay at home to follow their medication regime; Oral administration leads to side effects with blood medication levels sometimes rising to toxic levels or falling to subtherapeutic levels                                     | ambulatory while receiving the medication; transdermal drug delivery eliminate factors such as pH changes and food intake that influence gastrointestinal absorption; transdermal medication delivery device allows the vital signs of a patient to be monitored from a remote location.   |
| 2 | <a href="#">US20090306633</a> | 10/12/09 | Koninklijke Philips Electronics | Electronically controlled capsule   | When taking medications in the form of capsules, a log has to be maintained regarding what capsules has to be administered and at what intervals of time; Time-release capsules do not follow an exact dispensing or dissolving pattern while traveling through the alimentary tract | Electronically controlled capsule for delivering or dispensing a medicament according to a preset dispensing timing pattern while traversing through the gastrointestinal tract; Electronically controlled capsule allows a person to take all capsules substantially simultaneously, so that no more capsules are required for the day;         |
| 3 | <a href="#">US20080161779</a> | 03/07/08 | None                            | Implantable nano pump for drug delivery                                     | Detecting, evaluating, and treating people with hypertension wherein the drug treatment has its mix of favorable and unfavorable effects, costs and sometimes the treatment is inadequate.   | A real-time, self-actuated nano-pumps that respond to different blood pressure, blood lipid or blood glucose levels by having membranes of varying thickness, thus enabling multi-level blood pressure drug release.   |
| 4 | <a href="#">US20080152592</a> | 06/26/08 | Bayer Healthcare                | Method of therapeutic drug monitoring                                       | Therapeutic drug monitoring requires repeated drug monitoring through testing of a blood sample for the drug of interest. This can be unpleasant and very painful for individuals, especially if there is extensive sampling of the blood.   | A diffusion-based, continuous-monitoring system is used to monitor the effectiveness of delivering a therapeutic drug. The levels of the therapeutic drug, the metabolite of the therapeutic drug or the substance that is affected by the therapeutic drug is analyzed so as to determine the effectiveness of delivering the therapeutic drug. |
| 5 | <a href="#">US6562000</a>     | 05/13/03 | Medtronic                       | Single-use therapeutic substance delivery device with infusion rate control | Single-use devices are typically configured with a preset infusion rate and hence there is a need for variable infusion rate controlled drug delivery device.  | The single-use therapeutic substance delivery device is provided with infusion rate control, is versatile, small, and inexpensive  |
| 6 | <a href="#">US7780981</a>     | 08/24/10 | Chrono Therapeutics             | Biosynchronous transdermal drug delivery                                    | Failure to comply with a dosing regimen - rigid dosing schedule, forgetfulness or denial of a medical condition; There is a need for a non-invasive, reliable means of delivering drugs compounds in precisely timed and measured doses-without causing any patient inconvenience    | An automated and pre-programmable transdermal drug administration system that can synchronize and tailor drug administration to the human body's circadian rhythms to deliver varying dosages at varying times. This minimizes negative side effects, and increases efficacy of the dosing regimen.  |
| 7 | <a href="#">US7291497</a>     | 06/11/07 | Theranos                        | Medical device for analyte monitoring and drug delivery                     | Need for point of care devices that can detect biological macromolecular activity or drug concentration levels   | Medical device with a biometric recognition device capable of obtaining and comparing physical parameter data of an interaction between the  |

|    |                               |          |                    |  |  |   |
|----|-------------------------------|----------|--------------------|--|--|---|
|    |                               |          |                    |  | and accordingly administer a specific therapeutic agent at a localized site, within the body, in response to changes in biological macromolecular activity or drug concentration levels.   | disease marker biological analyte with the bio-active agent and a therapeutic agent releasing device that controls the release of the therapeutic agent from the reservoirs.  |
| 8  | <a href="#">US7236821</a>     | 06/26/07 | Cardiac Pacemakers | Chronically-implanted device for sensing and therapy                                 | Conventional cardiac stimulus devices do not monitor the mechanical performance of the heart; Leads used in conjunction with implanted pacemakers and defibrillators are implanted in a relatively few preselected sites in the heart which are not necessarily the optimal sites; The implanted leads occupy a relatively large volume in the blood vessels through which they are passed and sometimes have to be steered along circuitous routes; | A chronically-implanted device that is capable of providing sensing functions such as mechanical, electrical and chemical sensing functions as well as drug-eluting therapy functions. The device is capable of being implanted in a large number of desirable locations using less invasive procedures.  |
| 9  | <a href="#">US7052251</a>     | 05/30/06 | Medtronic Minimed  | Shape memory alloy wire driven positive displacement micropump with pulsatile output | Need for a more inconspicuous and less cumbersome infusion devices that are inexpensive, reusable and disposable   | Miniature fluid pump that is driven by a shape memory alloy wire to produce a pulsatile output and are constructed almost entirely from plastic components at an extremely low cost. The device require very little power to operate and are especially useful for long term pump applications. The device include a multi-day disposable device that employs a collapsible drug fluid reservoir bag and a reusable electronics module to control fluid delivery.   |
| 10 | <a href="#">US20100069888</a> | 03/18/10 | None               | Intelligent medical device system for personalized medicine applications             | The implantable medical devices are not "intelligent"but they are simple deterministic systems; They are also single function devices focused on a specific narrow medical problem and do not combine diagnostic and therapeutic functionality; The devices are not useful in personalized medicine, which require complex analysis and targeting of individual therapies to unique problem sets.  | The iMD system diagnoses neurological, cardiovascular, immune, endocrine and cancer pathologies and develops and applies solution options in real time to each of these subsystems or to all of them simultaneously. The system uses a combination of diagnostic and therapeutic modules in multiple iMDs in a network to identify and apply remedies to pathologies. The iMD system uses a variety of therapeutic modalities, including gene, RNAi and protein therapies, to solve complex medical problems. |

• Analyzed Patents

[Please click here to download the sample patent analysis sheet](#)

## Patent Ranking



| S. No. | Patent/Publication Number     | Node wise Rating      | Patent Granted/Publication Rating | Forward Citation Count Rating | Over All Rating | Over All Ranking |
|--------|-------------------------------|-----------------------|-----------------------------------|-------------------------------|-----------------|------------------|
| 1      | <a href="#">US7236821</a>     | Abstract: 3           | Granted: 2                        | 106                           | 125             | 1                |
| 2      | <a href="#">US6562000</a>     | Dependent Claim: 4    | Granted: 2                        | 34                            | 58              | 2                |
| 3      | <a href="#">US20080161779</a> | Independent Claim: 5  | Publication: 1                    | 0                             | 27              | 3                |
| 4      | <a href="#">US20090306633</a> | Dependent Claim: 4    | Publication: 1                    | 0                             | 22              | 4                |
| 5      | <a href="#">US20100069888</a> | Full Specification: 4 | Publication: 1                    | 0                             | 7               | 5                |

The patents have been ranked considering the following parameters, prioritized in the given order:

- Taxonomy node
- Granted patent/ Patent publication
- Citation count

Further ranking within the parameters is as given below:

• **Taxonomy node**

Independent claim ? rank 5  
 Dependent claim ? rank 4  
 Abstract ? rank 3  
 Title ? rank 2  
 Full specification ? rank 1  
 Background ? rank 0

• **Granted/Publication**

Granted patent ? rank 2  
 Patent publication ? rank 1

• **Citation Count**

All citations - rank 1

The weightage assigned for the parameters are:

Taxonomy node multiplied by a factor of 5  
 Granted Patent/Patent Publication multiplied by a factor of 2  
 Citation count multiplied by a factor of 1

The overall rating is calculated as shown below considering US7236821 as an example:

Taxonomy node: Abstract ? ranking is 3  
 Granted Patent ? ranking is 2  
 Forward citation count ? ranking is 1

$$\begin{aligned} \text{Overall rating} &= (\text{Taxonomy node} * \text{weightage } 5) + (\text{Granted Patent/Patent Publication} * \text{weightage } 2) + (\text{Citation count} * \text{weightage } 1) \\ &= (3*5) + (2*2) + (106*1) \\ &= 15 + 4 + 106 \\ &= 125 \end{aligned}$$

The patents are sorted according to the highest rating values and ranked accordingly.

## Sample Article Analysis

| S. No | Title   | Journals                                     | Dolcera Summary  |
|-------|---|--|--|
| 1     | <a href="#">Application of micro- and nano-electromechanical devices to drug delivery</a>           | Pharm Res.                                   | Drug delivery device containing micro- and nano-electromechanical systems (MEMS and NEMS), small-scale biosensor and drug reservoir units that can be combined, implanted and controlled through wireless integrated system to regulate drug release, receive sensor feedback, and transmit updates.   |
| 2     | <a href="#">Miniaturised Drug Delivery System with Wireless Power Transfer and Communication</a>    | MEMS Sensors and Actuators                   | A drug delivery system for ophthalmic application comprises of a MEMS device, control circuitry and a wireless system for power and communication. The device is aimed at being permanently implanted for delivery of daily doses of drug for upto a year.   |
| 3     | <a href="#">BioMEMS devices for drug delivery</a>   | Engineering in Medicine and Biology Magazine | Drug administration through MEMS based drug delivery devices which can be used for producing controlled delivery of drugs.   |
| 4     | <a href="#">A novel remote controlled capsule for site-specific drug delivery in human GI tract</a> | International Journal of Pharmaceutics       | Delivering site specific drugs through remote controlled capsule that employs micro-electronic mechanical system (MEMS) technology. When the micro-thruster is ignited by a radio frequency (RF) signal, the thrust force generated by the propellants pushes the piston forward and leads to a rapid and complete expulsion of therapeutic agents from the capsule. |

|    |  |   |   |
|----|--|---|---|
| 5  | <a href="#">Implantable Drug Delivery System With In-plane Micropump</a>                           | Theses and Dissertations, University of Texas     | Design for an implantable drug delivery system using MEMS micropump for forming a compact, inexpensive system. The force generated by the MEMS actuator and the displacement of the tip is determined with the help of FEM simulations using ANSYS.   |
| 6  | <a href="#">Design of an implantable active microport system for patient specific drug release</a> | Biomed Microdevices                               | An implantable active microport with a high-resolution volumetric dosing unit and a drug reservoir that can be programmed for time-modulated drug release.  |
| 7  | <a href="#">Swallowable-Capsule Technology</a>   | Pervasive Computing                               | A brief review on the swallowable capsules for GI tract diagnostics and therapeutic applications, history of the technology, present state of the art and ongoing research.   |
| 8  | <a href="#">Design of site specific delivery capsule based on MEMS</a>                             | Nano/Micro Engineered and Molecular Systems       | Non-invasive drug delivery to selected sites by means of delivery capsules based on MEMS technology wherein the drug release is actuated by a micro-heater array, an elastomeric bellows and a piston. A magnetic marker monitoring (MMM) system is used to monitor the location of the capsule.  |
| 9  | <a href="#">BioMEMS ?Advancing the Frontiers of Medicine</a>                                       | Sensors   | An overview of the applications and the opportunities of MEMS and microneedles in medicine.   |
| 10 | <a href="#">Microchips and controlled-release drug reservoirs</a>                                  | Microchips and controlled-release drug reservoirs | Developments and future trends of implantable, microchip containing drug delivery devices constructed in a variety of ways using micro and nanoelectromechanical systems (MEMS or NEMS) based technology. These devices allow localized delivery of drugs, programmable dosing cycles, automated delivery of multiple drugs, and dosing in response to physiological and diagnostic feedback. |

- Analyzed Articles

[Please click here to download the sample article analysis sheet](#)

## Product Analysis

| S.No. | Product Name                            | Company   | Microneedle | Microchip | Micropump/nonopump     | Material      | Flow rate          | Stroke volume | Other information     | Communicat |
|-------|---|-----------|-------------|-----------|------------------------|---------------|--------------------|---------------|-----------------------|------------|
| 1     | <a href="#">SynchroMed II Drug Pump</a> | Medtronic | –           | –         | –                      | Titanium      | 0.048 mL/day       | –             | –                     | –          |
| 2     | <a href="#">Jewel Pump</a>              | Debiotech | –           | MEMS chip | Nanopump-piezoelectric | –             | –                  | –             | –                     | Bluetooth  |
| 3     | <a href="#">Nanopump?</a>               | Debiotech | –           | MEMS chip | Nanopump-piezoelectric | Silicon wafer | –                  | –             | –                     | –          |
| 4     | <a href="#">MIP</a>                     | Debiotech | –           | –         | Piezoelectric          | –             | 0 to 100 $\mu$ L/h | 150 nl        | –                     | –          |
| 5     | <a href="#">Nanoject</a>                | Debiotech | Microneedle | –         | –                      | –             | –                  | –             | 300 and 1?000 microns | –          |
| 6     | <a href="#">DebioSTAR</a>               | Debiotech | –           | Nanopores | –                      | –             | –                  | –             | up to 250 nanometres  | –          |
| 7     | <a href="#">MicronJet needle</a>        | NanoPass  | Microneedle | –         | –                      | –             | –                  | –             | –                     | –          |

[Click here to download the detailed product analysis sheet](#)

## Dolcera Dashboard

**Data Filters**

- Doubly fed induction generator
  - Method/ algorithm/ Program
  - Parts (83)
    - Stator (69)
    - Rotor (73)
      - Rotor construction (69)
      - Rotor current controlle
      - Rotor angular position
    - Shaft (7)
    - Slip ring and brushes
    - Brushless (8)
  - Converter (98)
  - DC link (32)
  - Operation (28)
  - Control (120)
  - Filter (7)
  - Protection (25)
  - Energy storage (3)

**Information**

Patent Charts Patents Articles

**Different Views**

**Export Selected Data**

| Publication     | Title  | Assignee         | Pub  | Ap |
|-----------------|--|------------------|------|----|
| US6448735B1     | Controller for a wound rotor slip ring induction machine                                     | Abb Research     | 2002 | 20 |
| US20050189896A1 | Method for controlling doubly-fed machine  | Abb Research     | 2005 | 20 |
| WO2007027141A1  | Wind mill power flow control with dump load and power converter                              | Abb Research     | 2007 | 20 |
| US20070114978A1 | System for transmission of electric power  | Abb Research     | 2007 | 20 |
| US20090273187A1 | Control method   | Abb Research     | 2009 | 20 |
| US20100085783A1 | Method and system to influence the power generation of an adjustable speed generator         | Abb Research     | 2010 | 20 |
| US20090200000A1 | Systems and methods for synchronous speed avoidance in doubly-fed induction generators       | Acciona Windp    | 2009 | 20 |
| US20090200000A1 | Dc voltage regulator   | Acciona Windp    | 2009 | 20 |
| US20100002475A1 | Wind turbine control system and method   | Acciona Windp    | 2010 | 20 |
| US2010002402A1  | Low voltage ride through   | American Supe    | 2010 | 20 |
| WO2010002402A1  | Low voltage ride through   | American Supe    | 2010 | 20 |
| G82410386A      | Control system for a doubly-fed induction generator  | Areva T & D Uk   | 2005 | 20 |
| G82411252A      | Control system for a doubly-fed induction generator with varying speed                       | Areva T & D Uk   | 2005 | 20 |
| G82420456A      | Generator control having grid imbalance detector   | Areva T & D Uk   | 2006 | 20 |
| US20100013343A1 | Constant frequency and locked phase generator adaptable to variable torque                   | Beijing Institut | 2010 | 20 |
| US20050189896A1 | Method for operating a wind energy plant   | Dewind Gmbh      | 2005 | 20 |
| US20030052643A1 | Brushless doubly-fed induction machines employing dual cage rotors                           | Dual Stator Te   | 2001 | 20 |
| US20060192390A1 | Brushless doubly-fed induction machine control   | Dual Stator Te   | 2003 | 20 |
| US20090021013A1 | Control and protection of a doubly-fed induction generator system                            | Gamesa Innov     | 2006 | 20 |
| US20090021013A1 | Wind power system and method of operating it   | Gamesa Innov     | 2009 | 20 |
| US20090302608A1 | Wind power installation and method of modifying the blade pitch in a wind power installation | Gamesa Innov     | 2009 | 20 |
| EP1508951A1     | Continuous reactive power support for wind turbine generator                                 | Gen Electric     | 2005 | 20 |

**Multi Level Classification**

**Document PDF**

**Assignees**

**Claims:**

**Abstract:**

The direct torque control (DTC) principle is used to control the torque of a

1. A method for controlling the torque and power factor of a doubly fed machine using direct torque control, comprising the steps of: (a) calculating the estimated torque of said machine; (b) determining a torque error from said estimated torque and a reference torque; (c) calculating the desired rotor flux command  $\Psi_{r\_ref}$ ; (d) calculating the actual rotor flux  $\Psi_r$ ; (e) converting said actual rotor flux from the reference frame to the rotor reference frame by multiplying  $\Psi_r$  by  $e^{-j\theta}$

#### Dashboard Link

[Smart Drug Delivery Systems - Dashboard](#)

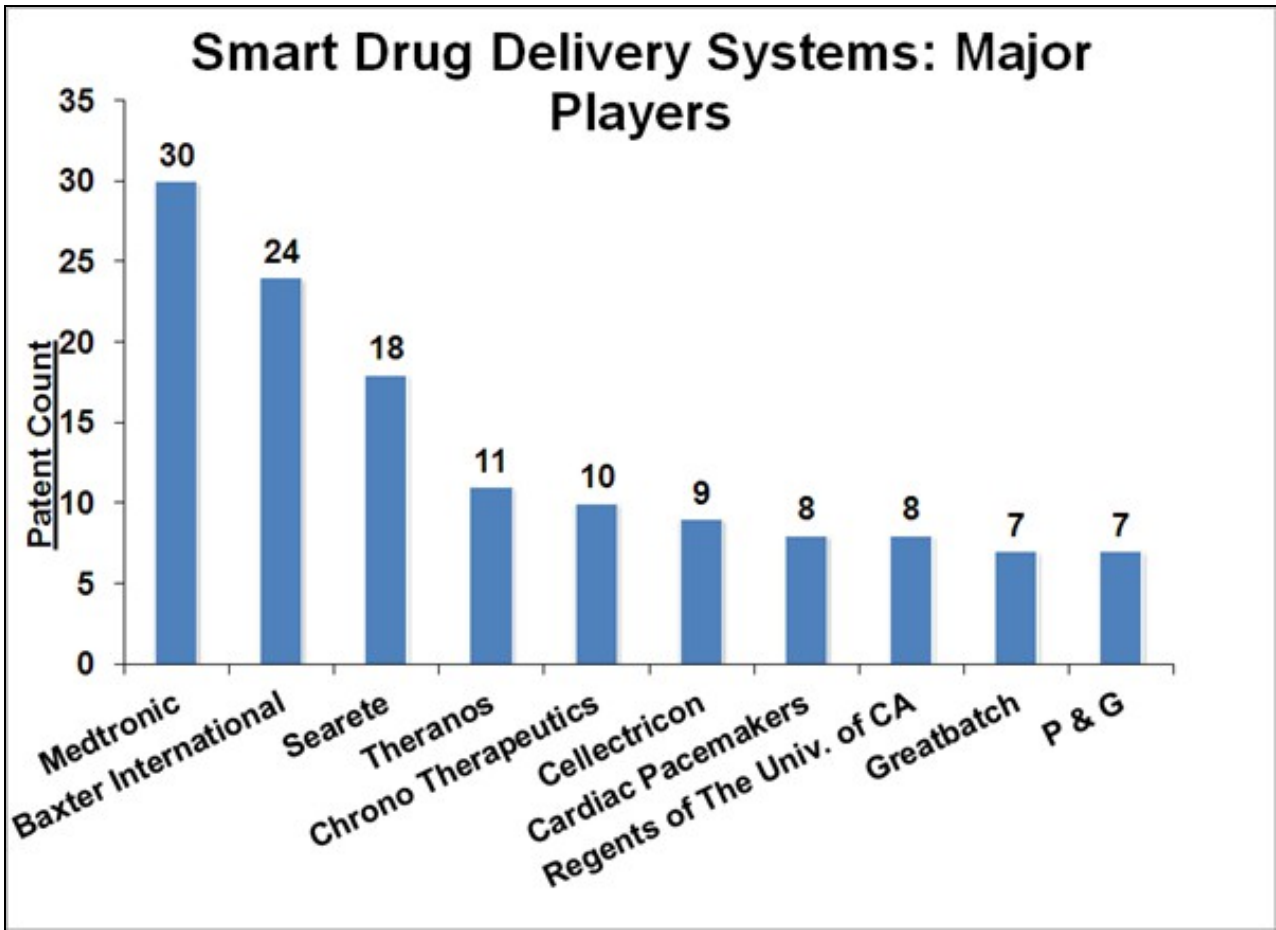


- Flash Player is essential to view the Dolcera dashboard

## Key Findings

### Major Players

- Medtronic and Baxter are the major players in the field of smart drug delivery system.

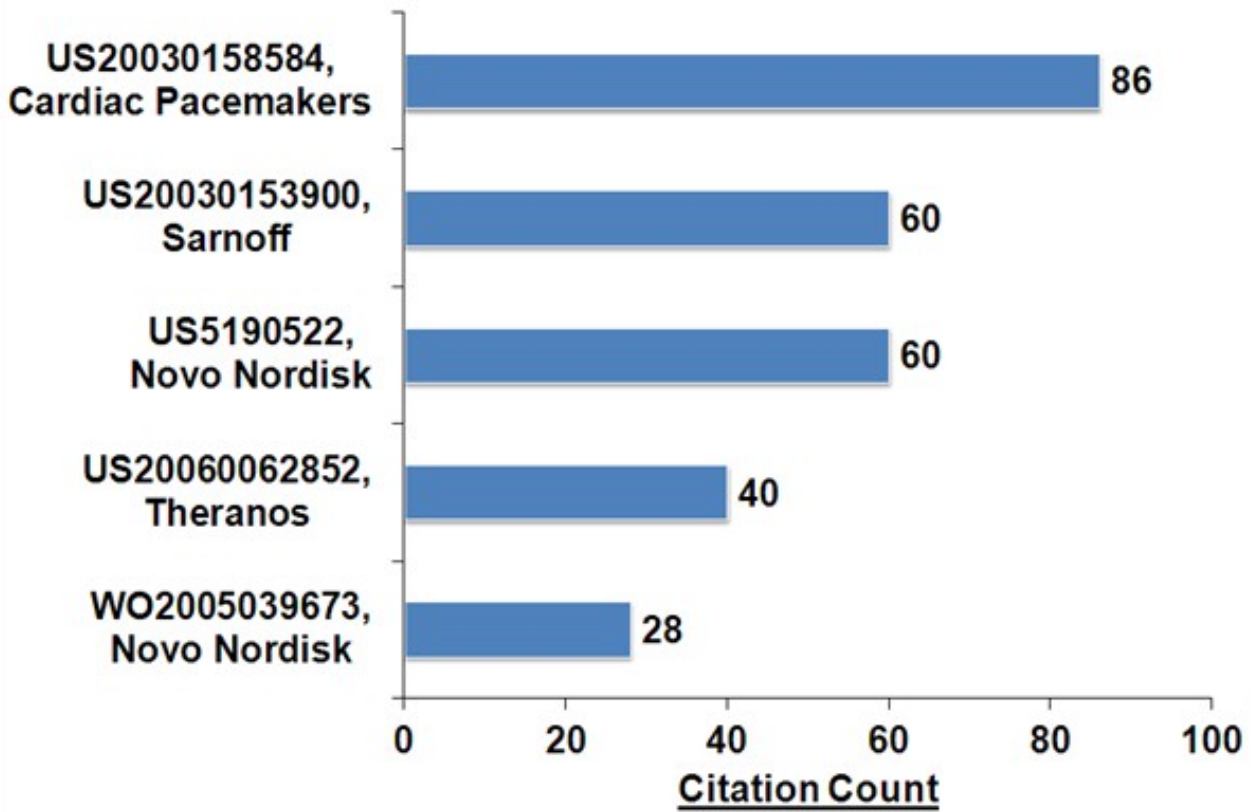


Major Players

#### Key Patents

- Key patents in the field are held by [Cardiac Pacemakers](#), [Sarnoff](#), [Novo Nordisk](#) and [Theranos](#).

## Top Cited Patents

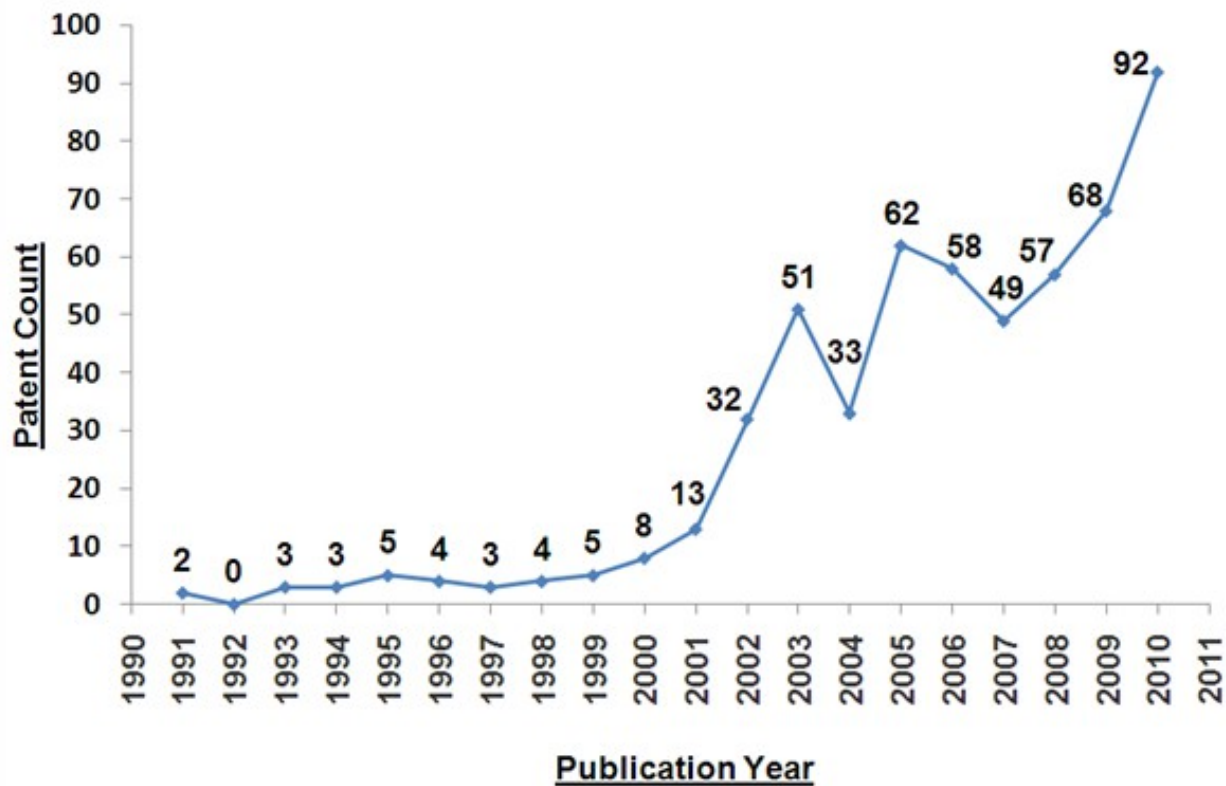


Key Patents

Year wise IP activity based on publication years



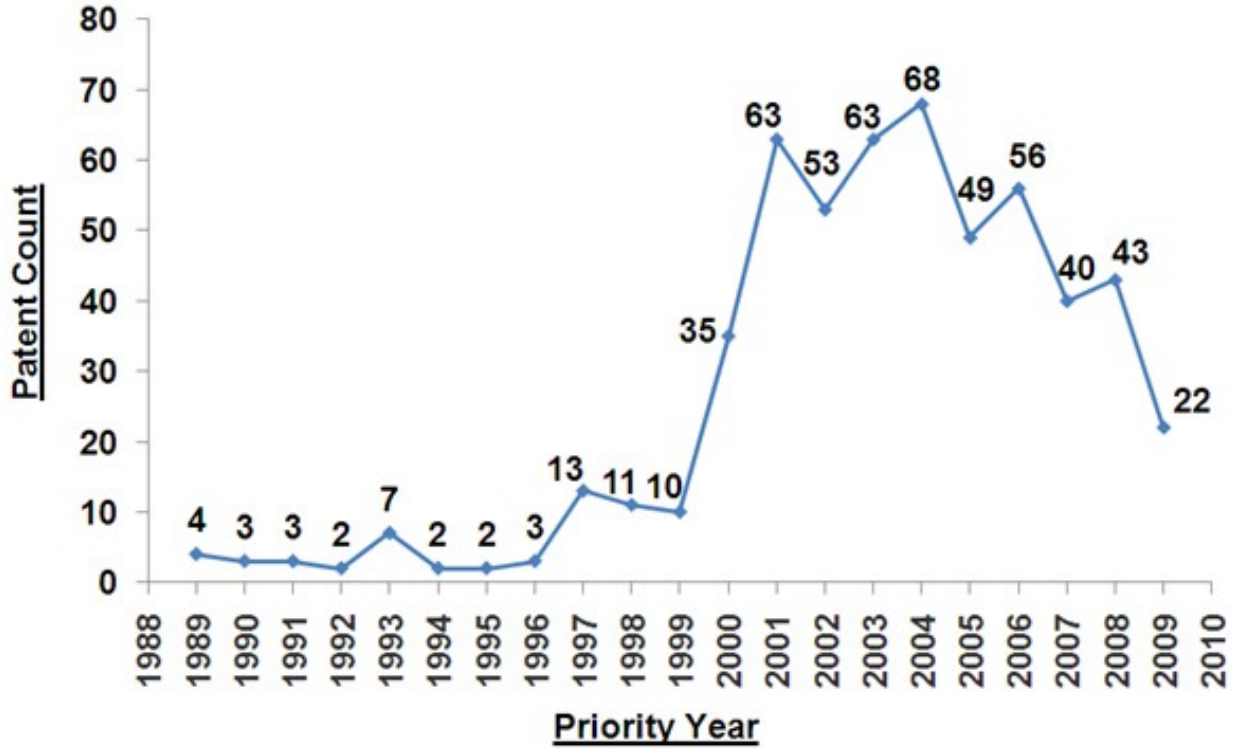
## IP Activity: Publication Year wise



IP activity based on publication years

Year wise IP activity based on priority years

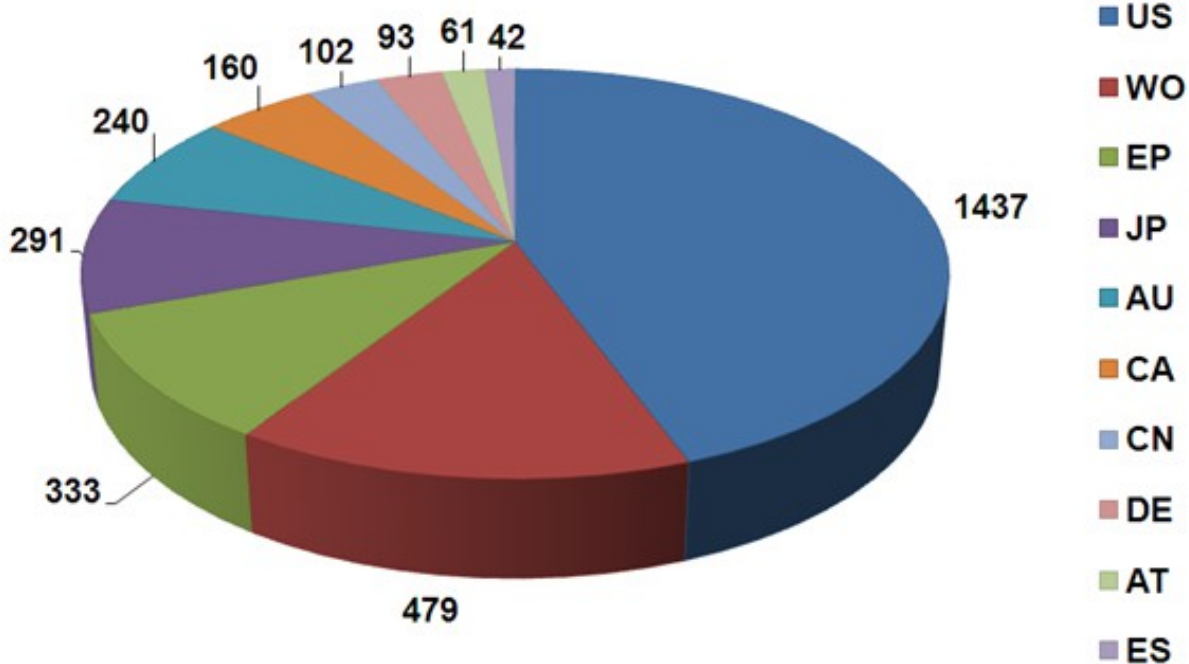
## IP Activity: Priority Year wise



IP activity based on priority years

## Patent Distribution

### Geographical Distribution of Patents



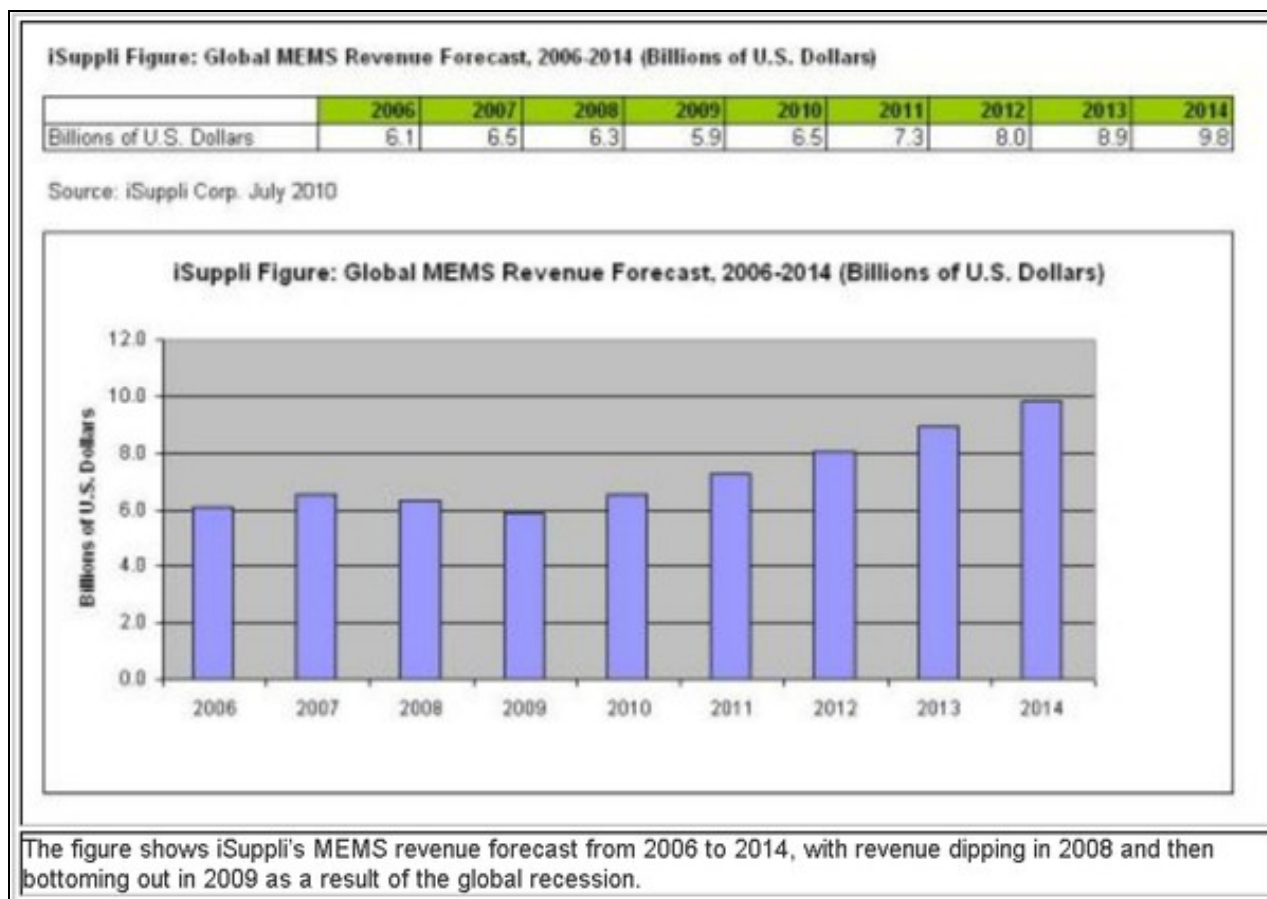
## Patent Distribution

- Our product search indicates that there are six smart drug delivery devices based on MEMS/NEMS while only three smart drug delivery devices are based on microneedles.
- Out of the six smart drug delivery devices based on MEMS/NEMS, two devices -- **IsoMed Drug Pump** and **SynchroMed II Drug Pump** -- from **Medtronic** have already been launched into the market. Furthermore, two out of the six **Jewel Pump** from **Debiotech**, and **MicroCHIPS'** **delivery device** are in clinical trial stage. These two devices are expected to be launched around the end of the year 2014 in the US.

## Market Analysis

### MEMS

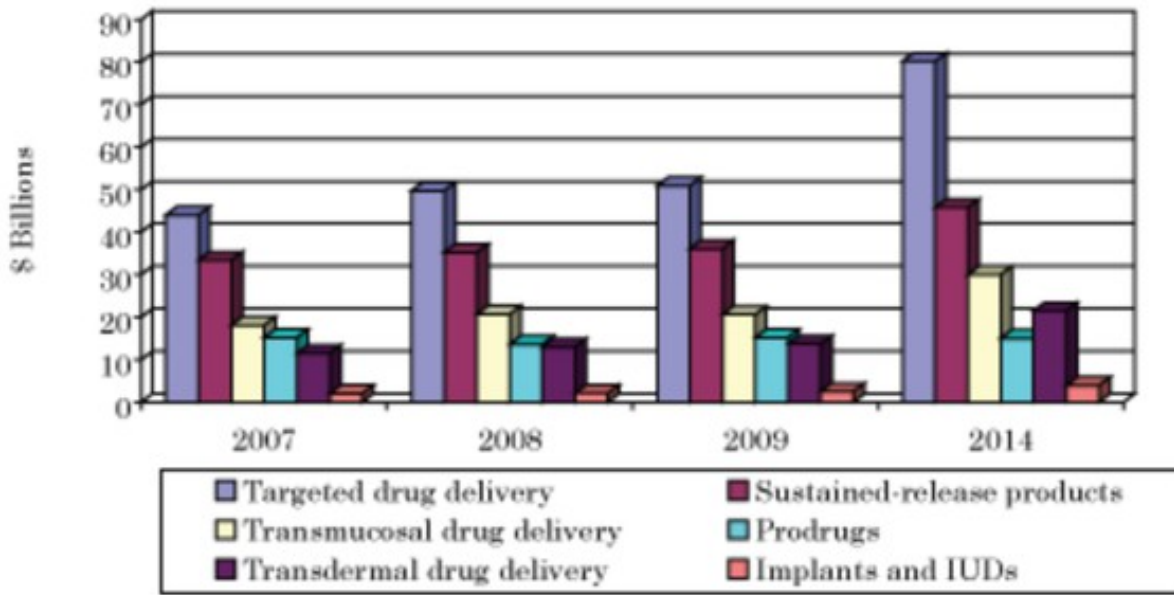
- MEMS is expected to grow from \$8 billion in sales in 2010 to \$16.4 billion by 2015, according to Yole Développement, a market research firm based in Lyon, France. The forecast reflects a compound annual growth rate (CAGR) of about 15 percent.
- iSuppli Corp., a market research firm based in El Segundo, Calif., forecasts MEMS device sales to climb from more than \$6 billion in 2010 to about \$10 billion in 2014, representing a CAGR of 11.6 percent. And it's possible that growth rate could continue through 2020, bringing the MEMS market to more than \$20 billion. [Source](#)
- One difference in the two forecasts is emerging MEMS markets in borderline device like electronic-compasses, which Yole counts but iSuppli does not include. Also, iSuppli only counts microfluidic devices cast on silicon substrates, whereas Yole includes microfluidics on polymer and glass substrates. [Source](#)



### Drug Delivery

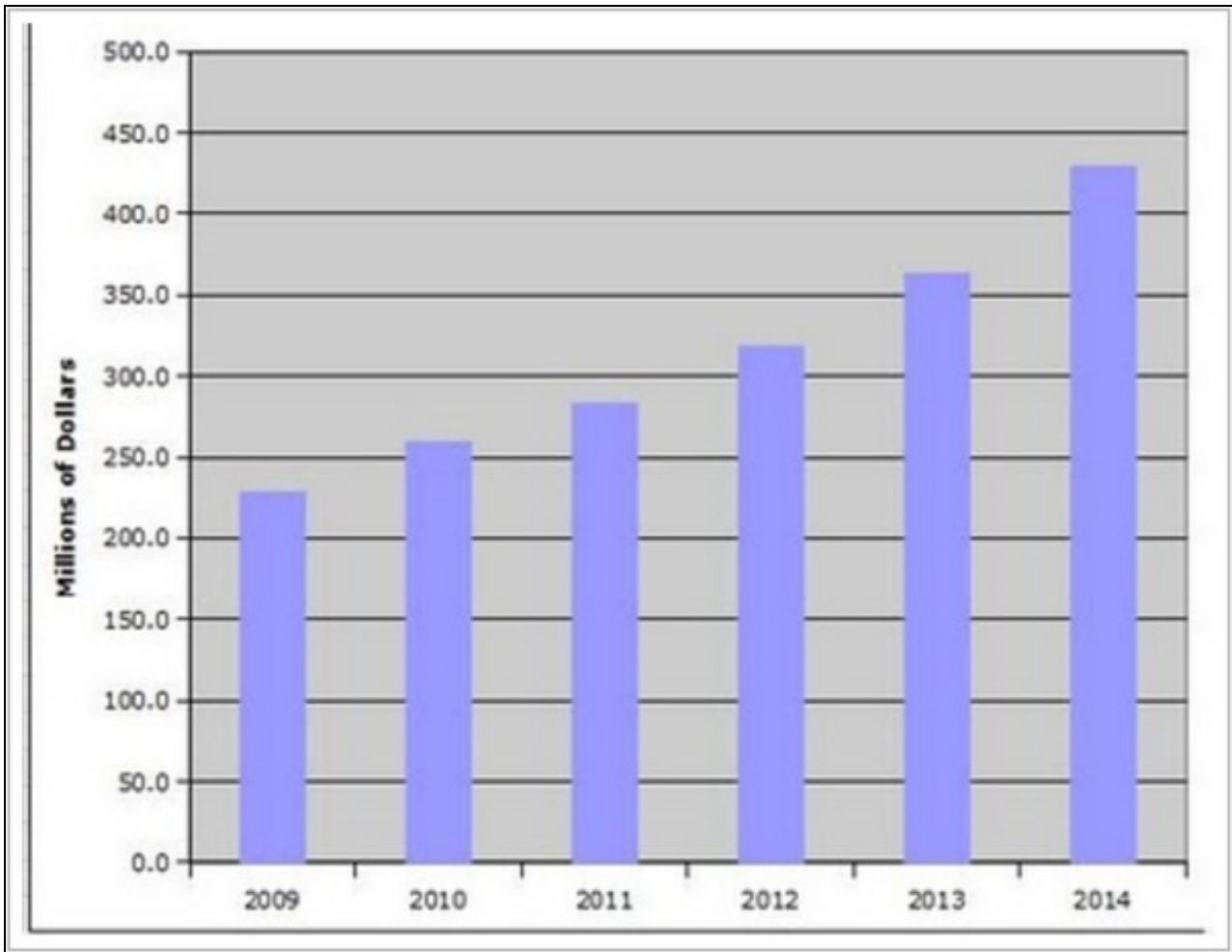
- The estimate for advanced drug delivery systems for 2014 is \$196.4 billion, for a compound annual growth rate (CAGR) of 7.2% in the 5-year period.
- The largest segment of the market is targeted drug delivery, which is expected to increase to \$80.2 billion in 2014, for a CAGR of 9.5%.
- Sustained-release products have the second-largest market share, with estimated sales of \$45.8 billion in 2014, for a CAGR of 4.9%. [Source](#)

**SUMMARY FIGURE**  
**GLOBAL SALES FOR DRUG DELIVERY PRODUCTS, 2007-2014**  
**(\$ BILLIONS)**



Source: BCC Research

- Major changes such as an aging population and growing obesity issues in many countries (leading for example to diabetes or other disorders) are impacting the medical MEMS market. These and other factors are among the motivations for making treatments less invasive or for monitoring the movements of the elderly. MEMS used in insulin pumps increase the efficacy and comfort of insulin drug delivery, for instance, while accelerometers monitor elderly people, tirelessly watching their movements, their position or presence in a bed, if they fall, and so on.
- Pressure sensors monitor gases during surgical operations or the treatment of sleep apnea. Accelerometers and gyroscopes assist surgeons by removing shake during precise operations. Emerging applications include implantable wireless pressure sensors, which are showing great promise in monitoring tell tale pressure buildup following heart surgery and are used for post-op monitoring of aneurisms. As a result markets for medical diagnostics and drug delivery devices enjoy 34% and 32% CAGR respectively from 2009 to 2014. [Source](#)
- The global market for MEMS used in medical applications is forecasted to reach \$430 million by 2014, up from \$229 million in 2009, equating to a CAGR of 13 percent, as shown in the figure.



**References**

- Nanojet Microneedle
- Jewel Pump
- Control Patents
- IsoMed Drug Pump
- SynchroMed II Drug Pump
- Medtronic
- Debiotech
- MicroCHIPS' delivery device
- MEMS Market Analysis
- MEMS Market Analysis
- Drug Delivery Market Analysis
- Drug Delivery Market Analysis

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