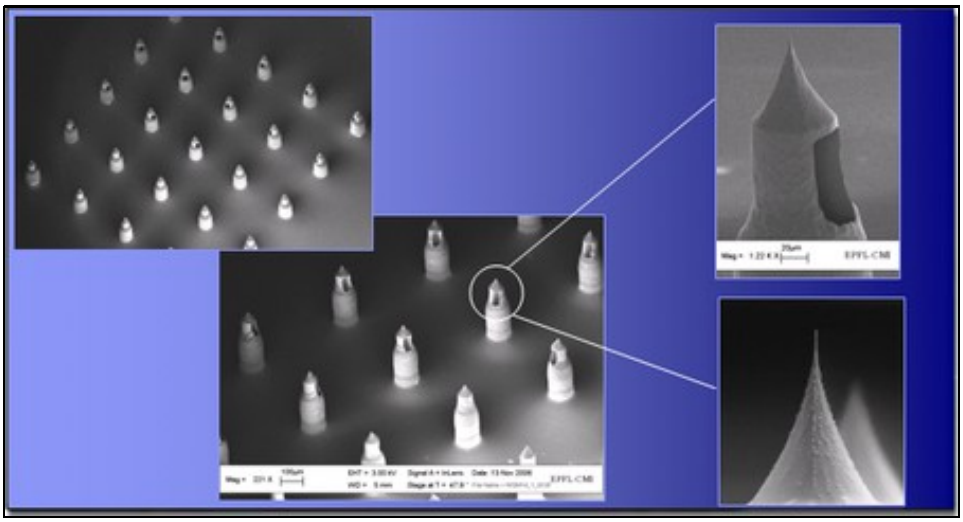
Smart Drug Delivery Systems

- The report captures the IP activity along with the key players in the smart drug delivery system industry.
- The report also captures the distribution of patents across the world.
- The IP information, competitor activity and the technology classification are also included.
- Prior art problems and their respective solutions given in different patents are captured in addition to the taxonomy nodes(technology breakdown classification).
- Product analysis is done for seven products.



Nanojet Microneedles

Jewel Pump

Contents

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	US6723086	04/20/04	Logiq Wireless Solutions	Remote controlled transdermal medication delivery device
2	US20070071596	03/29/07	Sensile PatAG	Liquid drug delivery micropump
3	US20060283465	12/21/06	Hewlett-Packard Development Company	Smart drug delivery system and a method of implementation thereof
4	US20050187515	08/25/05	Advanced Neuromodulation Systems	Reduced size programmable drug pump
5	US20040220498	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	US20060271020	11/30/06	Chrono Therapeutics	Portable drug delivery device including a detachable and replaceble administration or dosing element
7	US20080161779	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 électro ADJ2 mechani*) OR mems OR nems OR nanoélectromécani* OR (nano ADJ2 électro ADJ2 mechani*) OR micropompes OR (micro ADJ2 pompes) OR (micro ADJ2 fluidique*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 (Liefern 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 (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	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 fluidique) 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 télémétrie 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 réglementer) 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 (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 (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 (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 (jacobsen NEAR4 stephen) OR (jacobson NEAR4 james) OR (jandrisits NEAR4 alice) 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

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            cursor: pointer;
        }

        .markmap-node-circle {
            fill: #fff;
            stroke-width: 1.5px;
        }

        .markmap-node-text {
            fill:  #000;
            font: 10px sans-serif;
        }

        .markmap-link {
            fill: none;
        }

        pre, .mw-code{
          background-color: transparent;
        }
    d3.xml("https://www.dolcera.com/wiki/images/Smart_Drug_Delivery_Systems.mm", function(error, data) {
```

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  if (error) throw error;

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});
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Sample Patent Analysis

S. No.	Patent/Publication No.	Publication Date (mm/dd/yyyy)	Assignee / Applicant	Title	Dolcera Summary	
					Problem	Solution
1	US6723086	04/20/04	Logiq Wireless Solutions	Remote controlled trans-dermal medication delivery device	Ambulatory individuals requiring long term medication need to take medications at 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	Transdermal medication delivery provides constant and continuous absorption of the drug while allowing the patient to remain 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	US20090306633	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	US20080161779	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	US20080152592	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	US6562000	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	US7780981	08/24/10	Chrono Therapeutics	Biosynchronous transdermal drug delivery	Failure to comply with a dosing regimen - rigid dosing	An automated and pre-programmable transdermal drug

					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	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	US7291497	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 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.	Medical device with a biometric recognition device capable of obtaining and comparing physical parameter data of an interaction between the 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	US7236821	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	US7052251	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	US20100069888	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	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

					useful in personalized medicine, which require complex analysis and targeting of individual therapies to unique problem sets.	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	US7236821	Abstract: 3	Granted: 2	106	125	**1**
2	US6562000	Dependent Claim: 4	Granted: 2	34	58	**2**
3	US20080161779	Independent Claim: 5	Publication: 1	0	27	**3**
4	US20090306633	Dependent Claim: 4	Publication: 1	0	22	**4**
5	US20100069888	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

Overall rating = (Taxonomy node * weightage 5) + (Granted Patent/Patent Publication * weightage 2) + (Citation count * weightage 1)
=(3*5) + (2*2) + (106*1)
=15 + 4 + 106
=125

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

Sample Article Analysis

S. No	Title	Journals	Dolcera Summary

1	Application of micro- and nano-electromechanical devices to drug delivery	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	Miniaturised Drug Delivery System with Wireless Power Transfer and Communication	MEMS Sensors and Actuators	A drug delivery system for opthalmic 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	BioMEMS devices for drug delivery	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 novel remote controlled capsule for site-specific drug delivery in human GI tract	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	Implantable Drug Delivery System With In-plane Micropump	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	Design of an implantable active microport system for patient specific drug release	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	Swallowable-Capsule Technology	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	Design of site specific delivery capsule based on MEMS	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	BioMEMS ?Advancing the Frontiers of Medicine	Sensors	An overview of the applications and the opportunities of MEMS and microneedles in medicine.
10	Microchips and controlled-release drug reservoirs	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

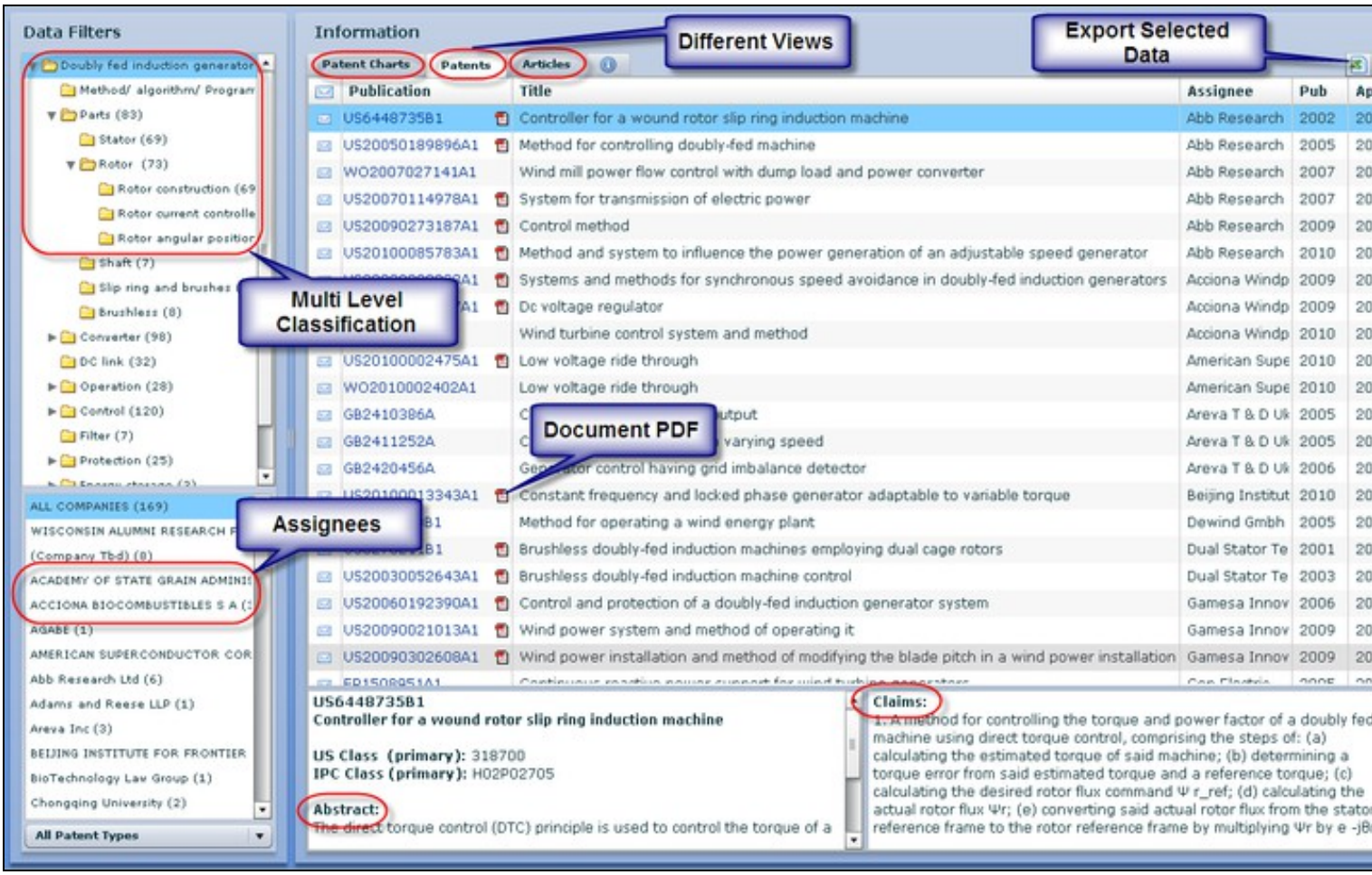
Please click here to download the sample article analysis sheet

Product Analysis

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

Click here to download the detailed product analysis sheet

Dolcera Dashboard



Dashboard Link

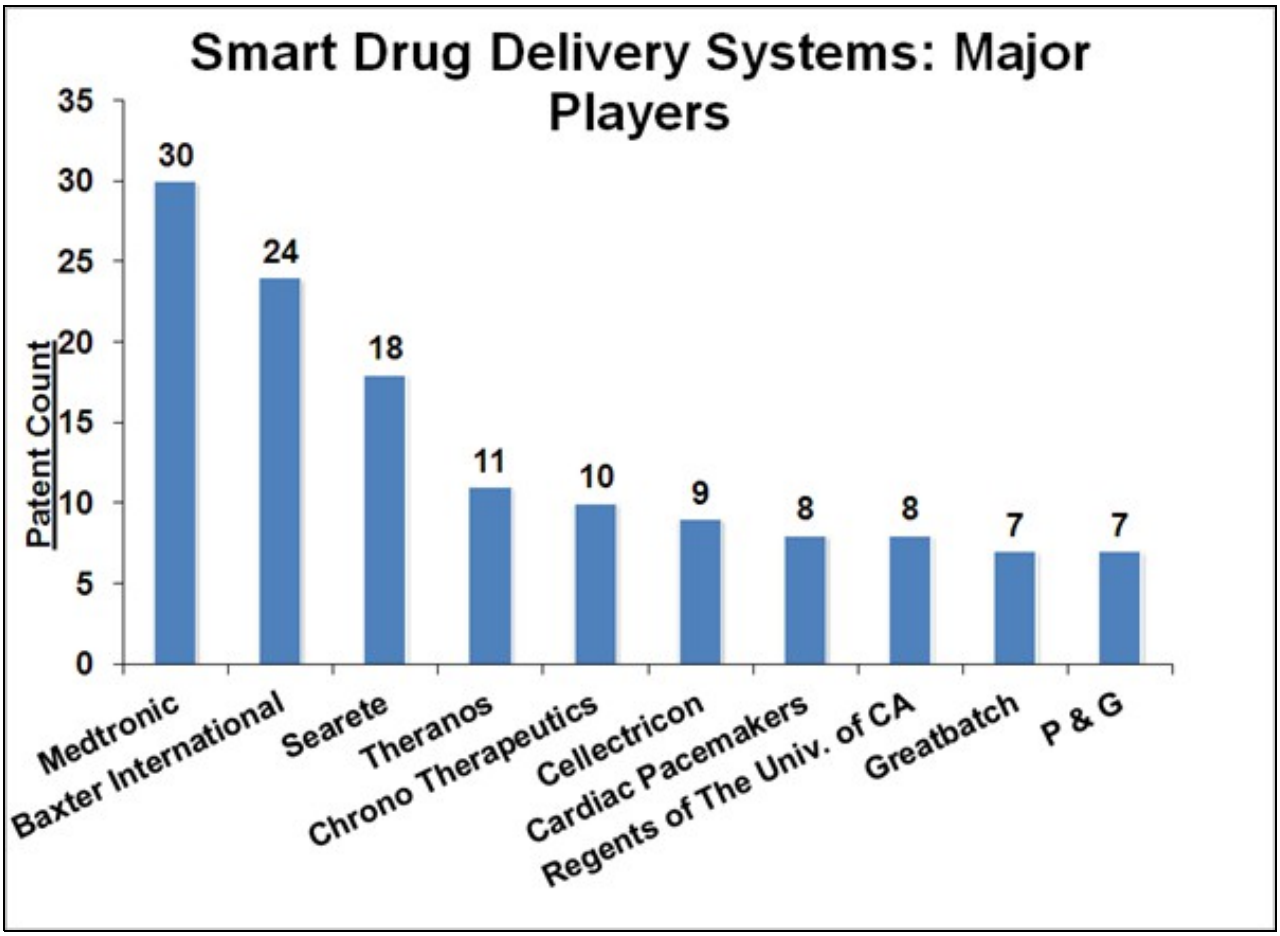
Smart Drug Delivery Systems - Dashboard	

- Flash Player is essential to view the Dolcera dashboard

Key Findings

Major Players

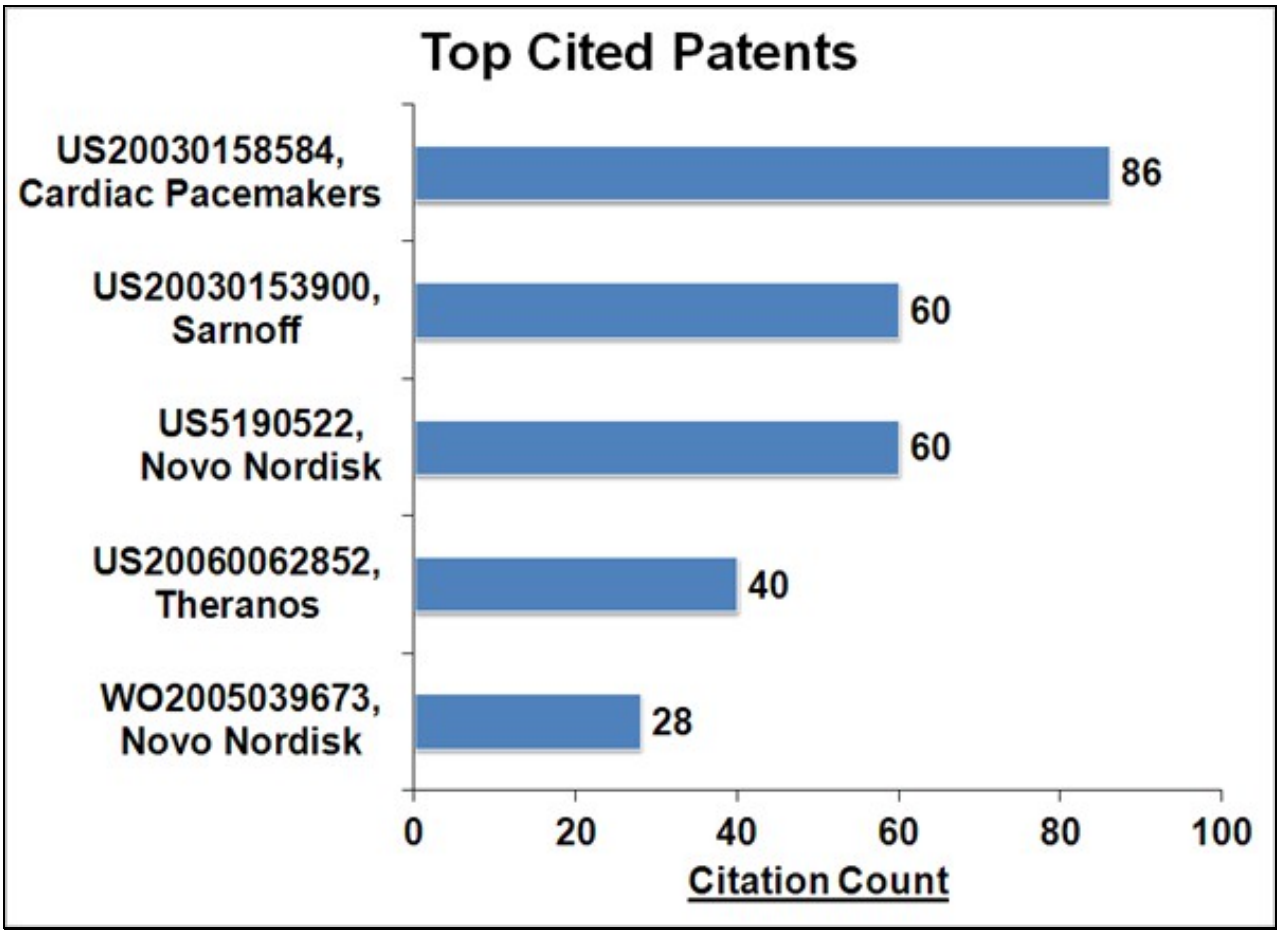
- Medtronic and Baxter are the major players in the field of smart drug delivery system.



Major Players

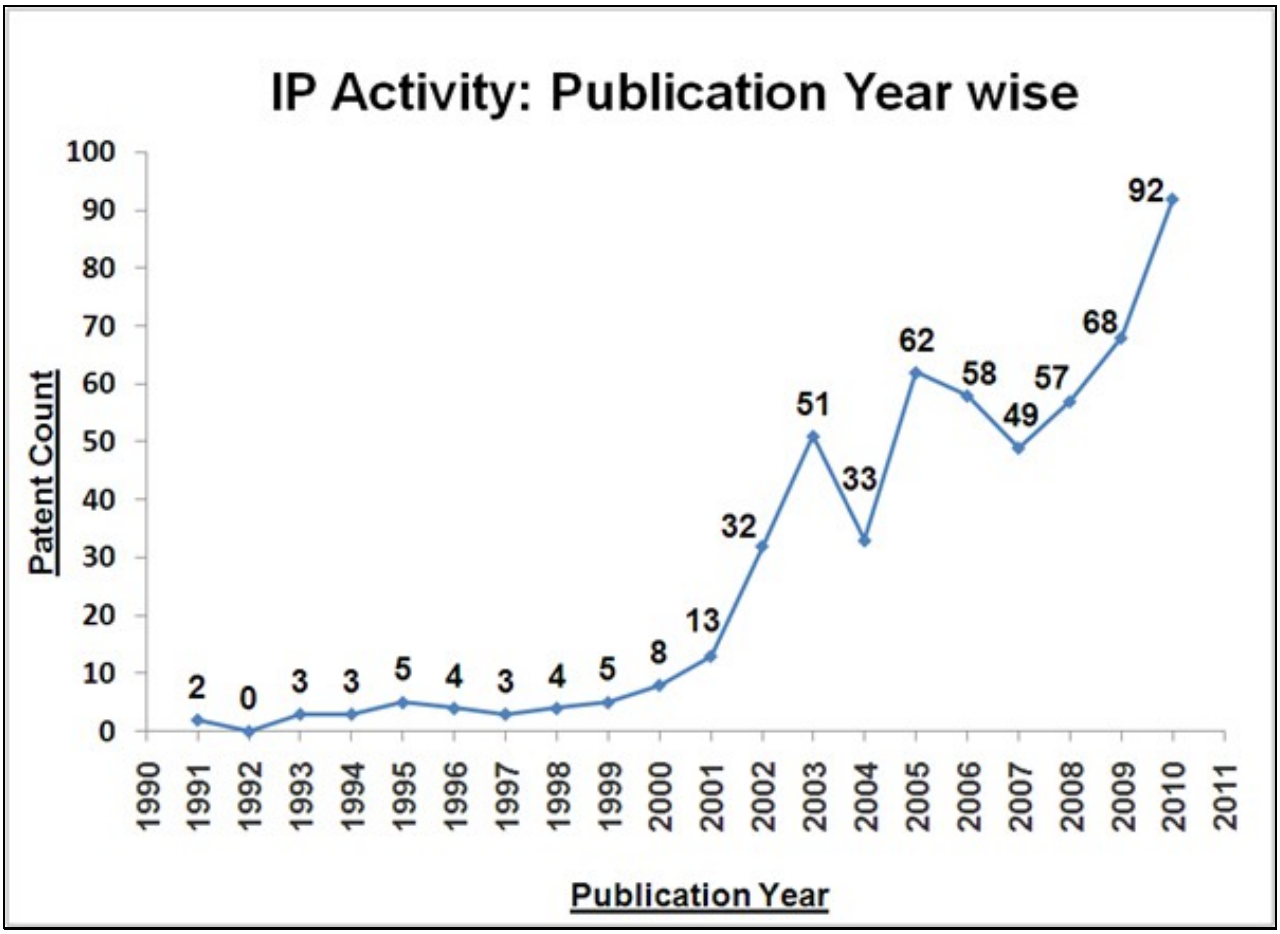
Key Patents

- Key patents in the field are held by Cardiac Pacemakers, Sarnoff, Novo Nordisk and Theranos.



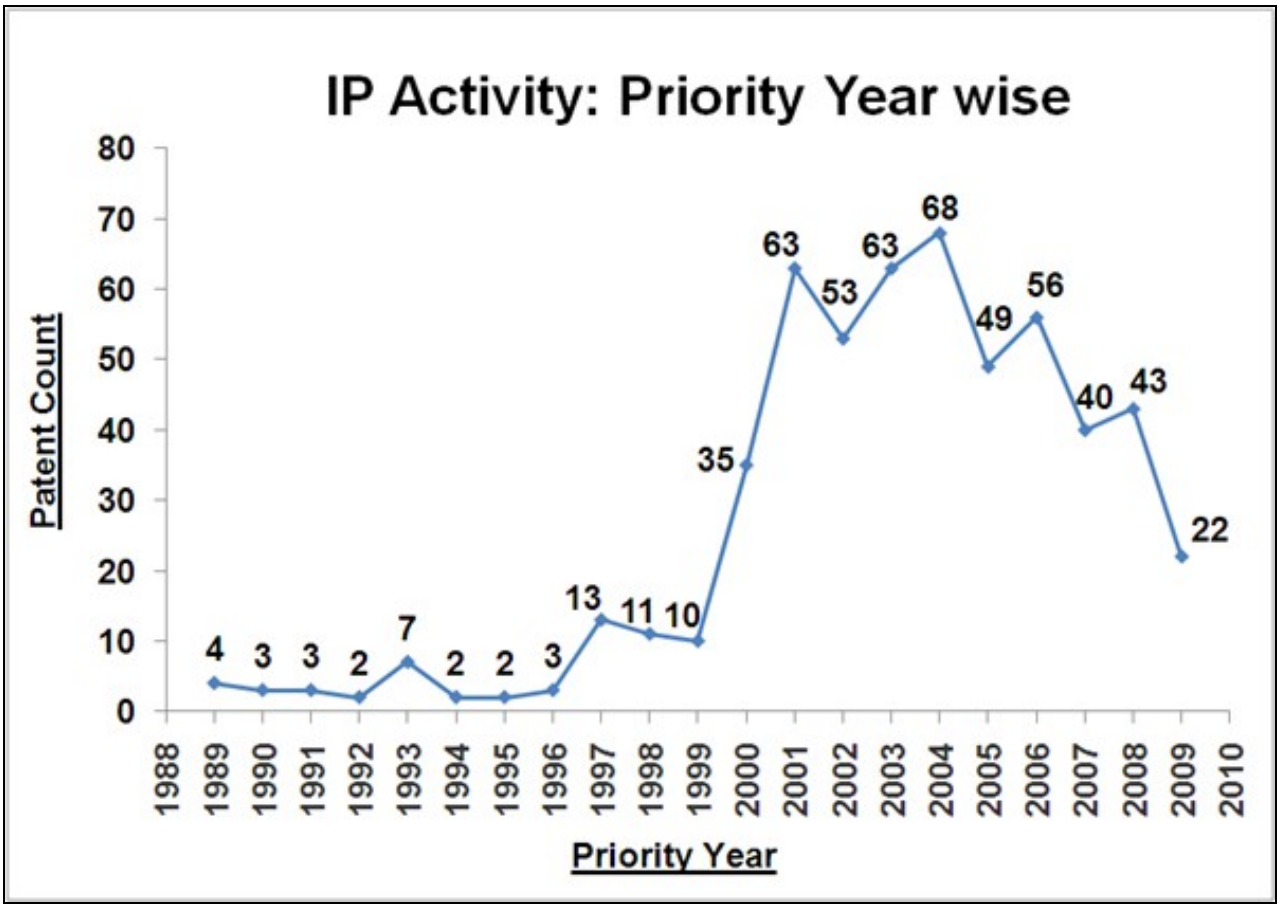
Key Patents

Year wise IP activity based on publication years



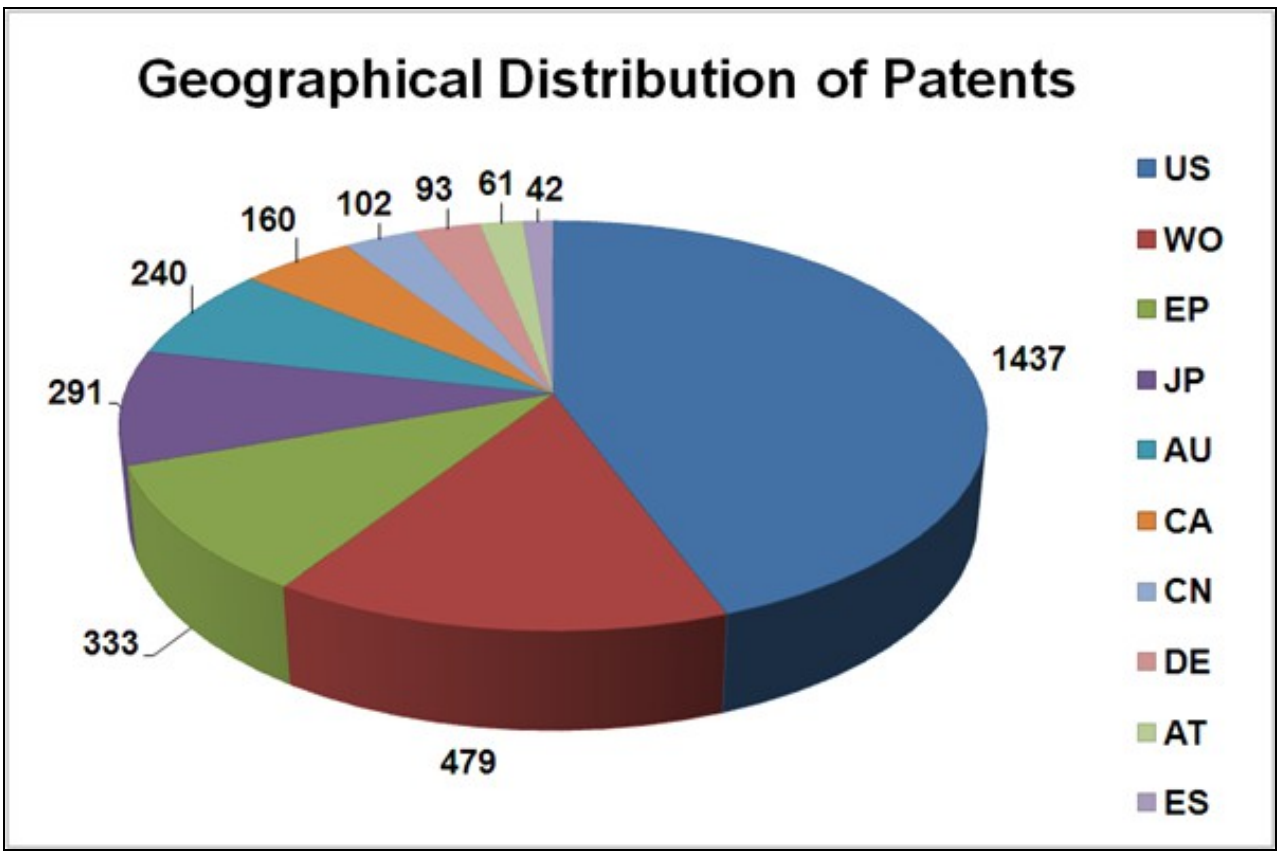
IP activity based on publication years

Year wise IP activity based on priority years



IP activity based on priority years

Patent Distribution



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

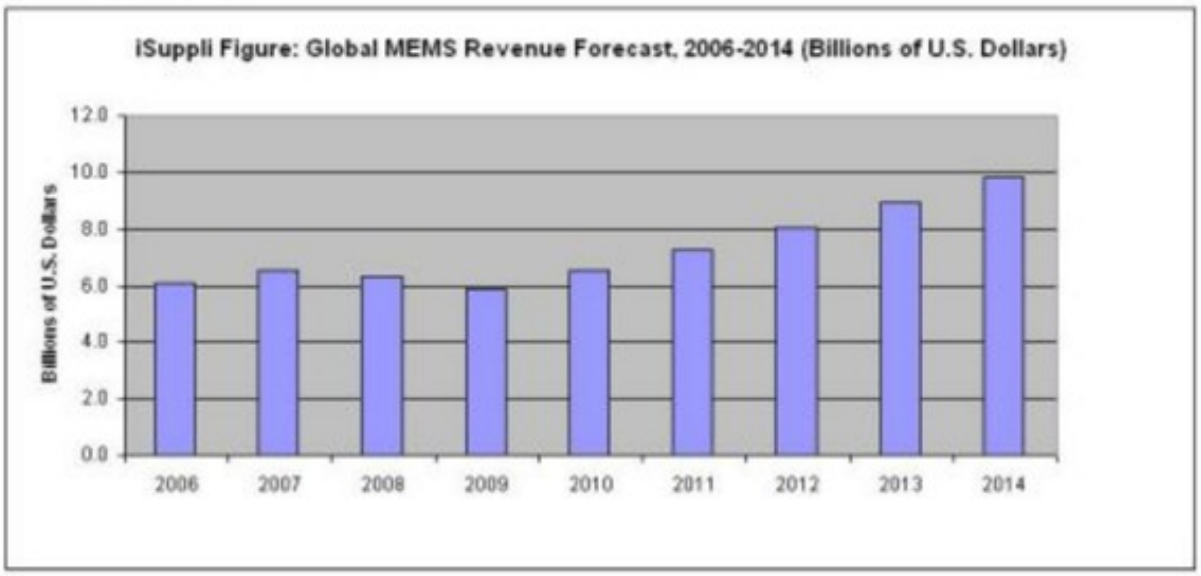
MEMS

- 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

iSuppli Figure: Global MEMS Revenue Forecast, 2006-2014 (Billions of U.S. Dollars)

	2006	2007	2008	2009	2010	2011	2012	2013	2014
Billions of U.S. Dollars	6.1	6.5	6.3	5.9	6.5	7.3	8.0	8.9	9.8

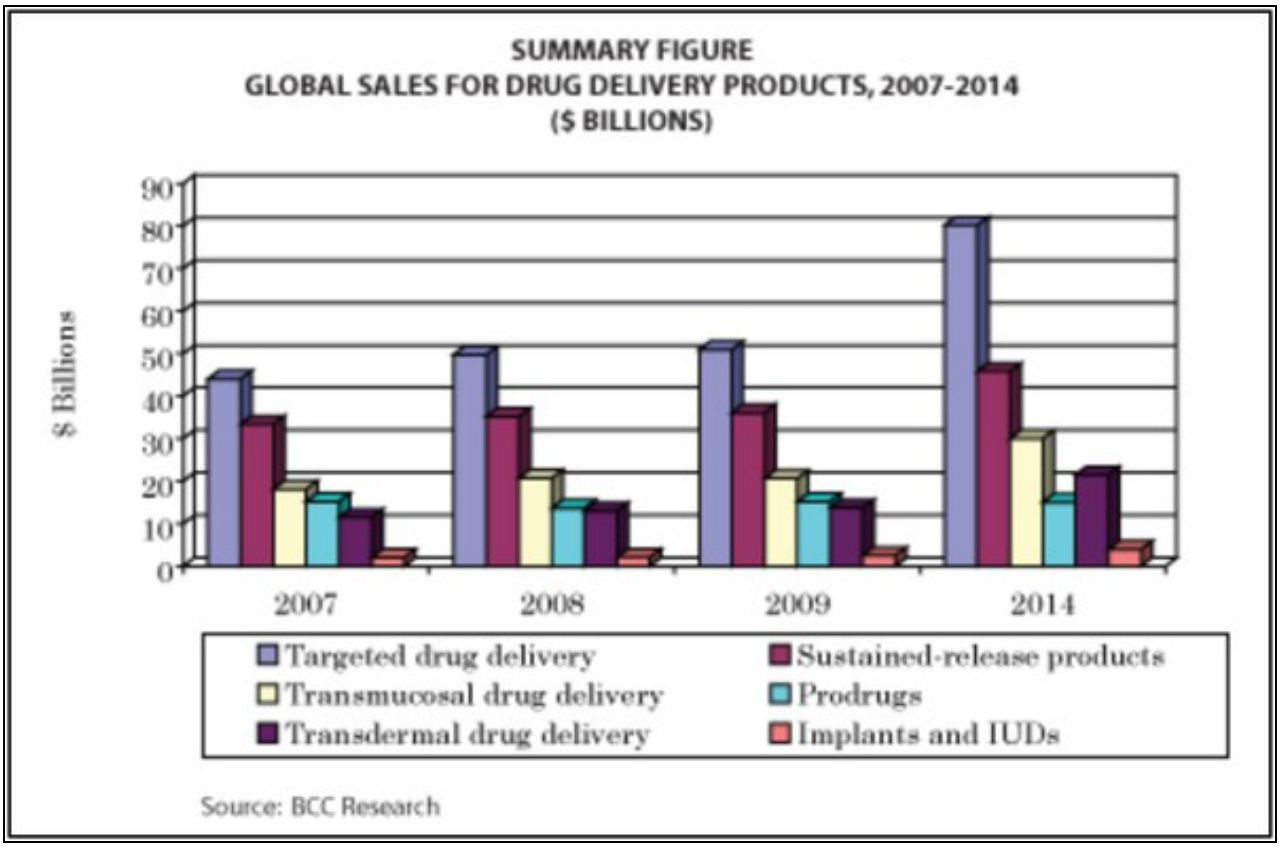
Source: iSuppli Corp. July 2010



The figure shows iSuppli's MEMS revenue forecast from 2006 to 2014, with revenue dipping in 2008 and then bottoming out in 2009 as a result of the global recession.

Drug Delivery

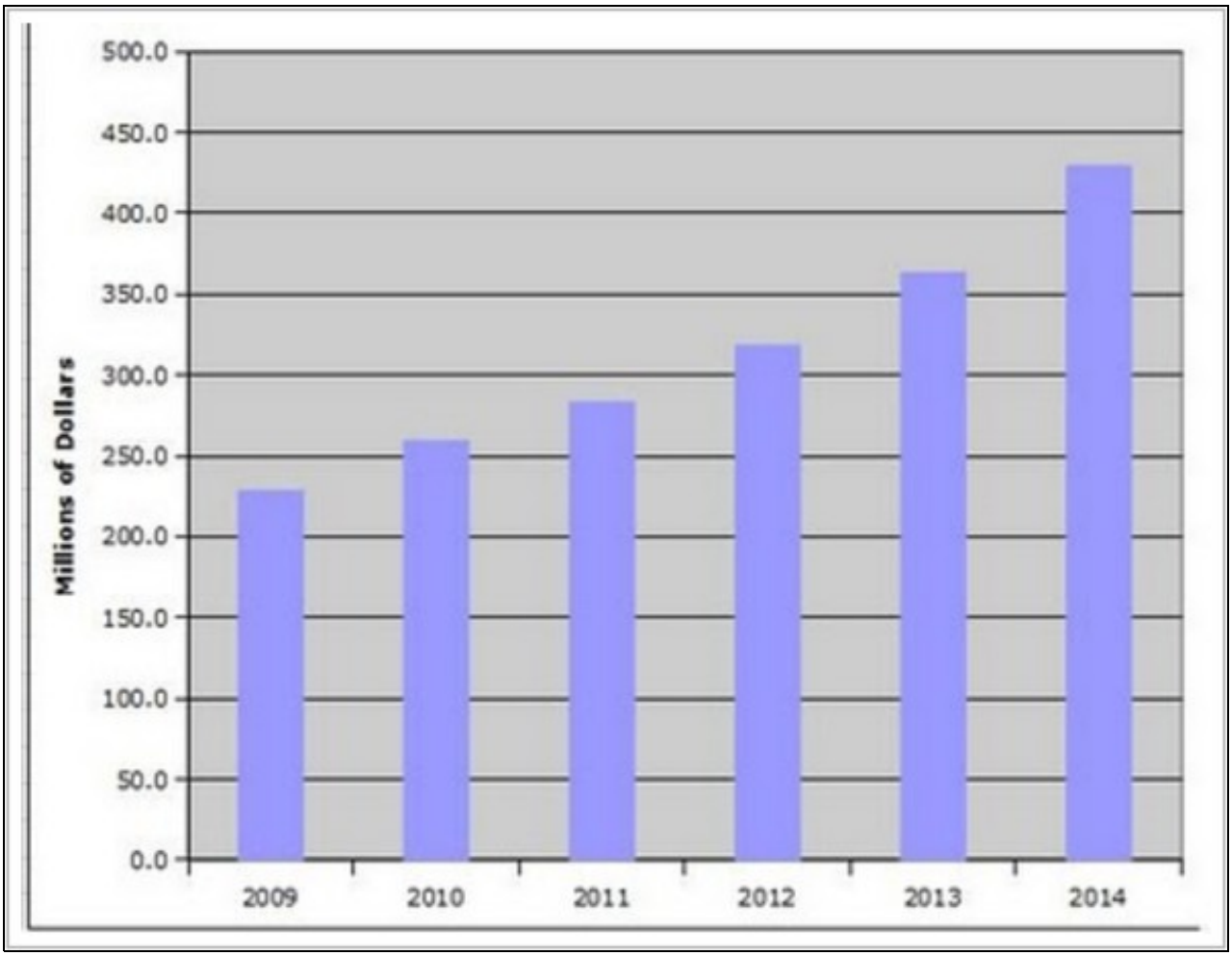
- The estimate for advanced drug delivery systems for 2014 is $196.4 billion, for a compound annual growth rate (CAGR) of 7.2% in the 5-year period.
- The largest segment of the market is targeted drug delivery, which is expected to increase to $80.2 billion in 2014, for a CAGR of 9.5%.
- Sustained-release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



- 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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