Ricard Solé's CV

Personal Information

Name: Ricard Solé
Date of birth: 05/11/1962
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Current Positions

Ricard Solé is **ICREA Research Professor** at **Universitat Pompeu Fabra (UPF)**, Department of Medicine and Life Sciences (MELIS), a position he has held since **January 1st, 2001**. His research areas include Complex Systems, Synthetic Biology, Systems Biology, Evolutionary Transitions, and Phase Transitions.

Other current positions include:

- External Professor Santa Fe Institute, New Mexico, USA. (Since 1998.)
- External Faculty Center for Evolution and cancer, UCSF, USA. (2010-2018)
- Science Board, European Centre Living Technology, Venice, Italy. (2016-2020)
- External Faculty Complexity Science Hub, Vienna, Austria. (Since 2017.)

Distinctions and awards

In 2004, he was awarded the **Premi Ciutat de Barcelona** for his research on the evolution and universality of human languages. https://ajuntament.barcelona.cat/premisciutatbcn/edicions/2003-2/investigacio-cientifica/

In 2015, he received the **Premi La Vanguardia de la Ciència**, acknowledging his contributions to synthetic biology and biocomputation.

In 2017, he was elected a Member of the **Academia Europaea**, in recognition of his sustained international impact on interdisciplinary science. https://www.ae-info.org/ae/Member/Solé_Ricard

In 2023, he was selected as recipient of the **Stanislaw Ulam Memorial Lectureship** at the **Santa Fe Institute**, a prestigious distinction awarded to scientists whose work spans multiple disciplines, honoring his contributions to the understanding of biological, cognitive, and artificial systems. https://www.santafe.edu/events/28th-annual-stanislaw-ulam-memorial-lectures-evolving-brains-solid-liquid-and-synthetic

Most recently, in 2025, he received the **ISAL Award for Outstanding Publication of 2024** from the International Society for Artificial Life for the paper *"Fundamental constraints to the logic of living systems"* (Interface Focus). This award recognizes influential research identifying universal theoretical limits on biological and artificial systems https://

www.santafe.edu/news-center/news/fundamental-logic-of-life-paper-receives-outstanding-publication-award

Supervision of graduate students and postdoctoral fellows

I have supervised so far 20 PhD thesis students since 2000 (https://www.icrea.cat/en/Web/ScientificStaff/rsole/theses#researcher-nav). Since 2010, 15 postdocs and four Fulbright MIT students have also trained in my lab.

In the last five years, five PhD students completed their thesis in the last five years (two more will defend their PhDs in 2026):

Jordi Piñero (PhD, 2023)
Towards a statistical physics of major evolutionary transitions: information, thermodynamics and ecology at the mathematical foundations of evolution
Universitat Pompeu Fabra. Supervisor.

Adriano Bonforti (PhD, 2022)
Modelling the dawn of simple multicellularity: cooperation, physics and evolutionary branching
Universitat Pompeu Fabra. Supervisor.

Blai Vidiella Rocamora (PhD, 2022)
Terraforming Earth's ecosystems: engineering ecosystems to avoid anthropogenic tipping points
Universitat Pompeu Fabra. Co-supervisor. ***Extraordinary Award by the UPF***

This Phd also received several awards: Jorge Wagensberg Award by the Complex Systems Catalan Association, Premio a las tesis más relevantes (CSIC).

Instiutional responsibilities

2014-2024 Coordination and teaching of Complex Diseases course (BME)
2012-2023 Coordination and teaching of Principles of Biological Design course (BME)
2005-2018 Evaluator of Postdoc candidates for Santa Fe Institute Omydiar Fellowships
2001-2020 Member of Artificial Life Committees for several ECAL workshops
2012-2015 Coordination and teaching of Mathematical Biomodelling course (BME)
2010-2012 Development of BME course contents for the UPF Department of Life Sciences
2009-2010 Coordination/design of the UPF 4-yr degree of Biomedical Engineering (BME)

Reviewing activities

- Member of the **Editorial Boards** of: *Biology Direct* (2010-), *PLoS ONE* (2005-), and *Philosophical Transactions Royal Society B* (2020-2025).
- Frequent reviewer, including: *Science, iScience, Science Advances, Science Robotics, Nature, Nature Communications* (including writing several News & Views and Perspectives pieces), Nature Human Behaviour, Nature Robotics, *BMC Systems Biology, Evolution, J. Theor Biol, Physical Review, Physical Review Letters, PLoS Biology, PLoS Computational*

Biology, PLoS ONE, PNAS, Proceedings Royal Society B, PRS Interface, and *Science Advances*

Previous positions

Period	Position/Institution/Country/Interruption cause
1997-2005	Senior/Founding Member, NASA-associated Center for Astrobiology, Spain.
1997-2001	Full Professor, Physics, Universitat Politècnica de Catalunya, Spain.
1993-1997	Associate Professor, Physics, Universitat Politécnica de Catalunya, Spain.
1989-1993	Lecturer, Physics, Universitat Politécnica de Catalunya, Spain.

Education

PhD, Licensed, Graduate	University/Country	Year
Ph.D. in Physics	Universitat Politècnica de Catalunya (UPC), Spain.	1991
B.S. in Physics	Universitat de Barcelona (UB), Spain.	1988
B.S. in Biology	Universitat de Barcelona (UB), Spain.	1986

CV SUMMARY

The candidate has published >300 peer-reviewed scientific articles (full list available on Google Scholar), with over >34,000 citations and an h-index of 88 (January 2026, I-index 289). These publications cover a wide range of scientific domains within complex systems, including bio-computation, information theory, systems and synthetic biology, network science, ecology, and evolution. Over the last 35 years, his research has focused on the emergence and evolution of complexity in natural and artificial systems, addressing this problem across multiple organizational scales, from proteins and cells to ant colonies and ecosystems.

The candidate was trained both as a biologist and as a physicist (holding a five-year degree in each discipline), and interdisciplinary research has been central to his scientific profile. His early work combined nonlinear dynamical systems and chaos theory with biological applications, leading to extensive contributions in theoretical and mathematical biology and ecology. In 1991, he founded his own research group, which later evolved into the Complex Systems Lab (CSL) at Universitat Pompeu Fabra. The CSL is internationally recognized as a leading research group in complex systems and currently includes seven members (three postdoctoral and four predoctoral researchers) from biology, physics, and computer science.

In the mid-1990s, following research visits to Brian Goodwin's group at the Open University, Stuart Kauffman's group at the Santa Fe Institute, Per Bak at Brookhaven National Laboratory, and José Costa at Yale University, the candidate became an External Professor at the Santa Fe Institute. During this period, he played a key role in the early development of network theory applied to biological and technological systems, contributing highly cited papers on the architecture of ecological, cellular, computational, and linguistic networks. In

2001, he was appointed ICREA Research Professor at UPF and subsequently served as principal investigator in several major European projects, including DELIS, ECAGENTS, and PACE, the latter focused on protocell engineering.

These projects, together with a James S. McDonnell Foundation grant on the evolution of biological networks, marked a transition toward an engineering perspective on biological complexity and the development of synthetic biology approaches. He later coordinated the FP6 CELLCOMPUT project and was awarded an ERC Advanced Grant (SYNCOM), which demonstrated distributed biological computation in engineered multicellular systems (Nature, 2011). In parallel, he received long-term support from the Botín Foundation (2010–2020) to establish a synthetic biology laboratory, contributing to the development of an ambitious research on biocomputation and cognition that included our own Synthetic Biology Wetlab. At the conceptual level, the candidate has played a leading role in shaping theoretical frameworks in synthetic and evolutionary systems. He co-organized (as a main organizer) several international workshops at the Santa Fe Institute (see below).

Recent research:

My recent research in complex systems focuses on three closely related domains: **synthetic multicellularity, hybrid cognition, and fundamental constraints on living systems**, combining theoretical modeling, synthetic biology, and complex systems theory to study how higher-level functions emerge from interacting components across scales.

In the area of **synthetic multicellularity**, I have investigated how engineered cell collectives can be used as experimental and conceptual platforms to study the emergence of development, organization, and agency. This work frames multicellularity as a major evolutionary transition that can now be explored through bottom-up bioengineering, identifying morphospaces and design principles for constructing multicellular systems that exploit self-organization rather than top-down control (https://www.nature.com/articles/s41586-023-06366-0).

In parallel, my work on **hybrid cognition** develops a general framework for systems in which biological and artificial agents are coupled into integrated cognitive units, ranging from microbial consortia and biohybrid robots to human–AI systems. This research introduces cognitive morphospaces that place natural, artificial, and hybrid agents within a unified theoretical landscape, emphasizing cognition and agency as emergent properties of embodied, multiscale interactions (https://royalsocietypublishing.org/doi/10.1098/rstb.2022.0053).

At a more fundamental level, I have contributed to a general theory of **constraints on the logic of living systems**, identifying universal limits imposed by thermodynamics, information theory, computation, development, and ecosystem structure. This work argues that although evolution is historically contingent, the space of possible living systems is strongly structured by deep physical and informational constraints, leading to convergent architectures and defining the boundaries of what forms of natural and synthetic life are in principle realizable (https://royalsocietypublishing.org/doi/10.1098/rsfs.2024.0010).

Finally, my recent research in bioengineering ecosystems has focused on developing a complex systems framework for understanding how **biodiversity constrains, stabilizes, and enables large-scale ecological interventions**. In this work, we have explored how synthetic biology can be used to design and deploy engineered strains within resident communities, not as replacements but as functional components that exploit existing ecological networks. Using

population dynamics and resource–consumer models, we have defined a space of possible synthetic ecosystems and identified key motifs governing stability, resilience, and scalability, from microbial consortia to macro-scale engineered habitats (https://doi.org/10.1021/acssynbio.4c00384).

A central result of this research is the demonstration that **biodiversity acts as a systemic "firewall"** against unintended consequences of synthetic interventions. We showed that high-diversity communities strongly constrain invasion dynamics, allowing engineered strains to enhance ecosystem function (e.g., resource retention or stress buffering) while minimizing extinction cascades and preserving overall community structure (https://doi.org/10.1098/rsos.231526). At a broader conceptual level, this work is embedded in a long-term research program on **ecological complexity, resilience, and tipping points**, where biodiversity emerges as a key control parameter for ecosystem stability and a central asset for future restoration and terraformation strategies (https://doi.org/10.1098/rstb.2021.0376). Importantly, these studies are not limited to the theoretical arena. These theoretical developments are currently being translated into experimental practice through an ongoing collaboration with EMBL within the **SYNTERRA project**, which aims at the experimental terraformation of dryland ecosystems using engineered microbiomes (https://www.embl.org/about/info/planetary-biology/projects/synterra/).

In addition to his research activities, the candidate has contributed substantially to interdisciplinary education. He was a co-designer of the four-year undergraduate degree in Biomedical Engineering at Universitat Pompeu Fabra, which has been running for over 20 years and integrates complex systems, synthetic biology, and evolutionary dynamics into its core curriculum.

I am also the author of several **popular and technical science books**:

Solé, R. (2023). *Todas las muertes: El final de la vida, de los océanos a los robots*. Editorial Crítica, Barcelona.
→ To appear in English as ***Endless Endings*, Princeton University Press, 2026**.

Solé, R., & Elena, S. F. (2018). *Viruses as Complex Adaptive Systems*. Primers in Complex Systems. **Princeton University Press**.

Solé, R. (ed.) (2017). *Phase Transitions*. **Princeton University Press.**

Solé, R. (2016). *La lógica de los monstruos*. Tusquets Editores, Barcelona.

Solé, R. (2012). *Vidas sintéticas: Una aproximación revolucionaria a la ciencia, la historia y la mente*. Tusquets Editores, Barcelona.

Solé, R. (2009). *Redes complejas: Del genoma a Internet*. Tusquets Editores, Barcelona.

Solé, R., & Bascompte, J. (2007). *Self-Organization in Complex Ecosystems*. **Princeton University Press.**

Solé, R., & Manrubia, S. C. (2002). *Orden y caos en sistemas complejos: Fundamentos*. Universitat Politècnica de Catalunya.

Solé, R., & Goodwin, B. (2001). *Signs of Life: How Complexity Pervades Biology*. **Basic Books, Harper & Collins**, New York, NY.

LIST OF PUBLICATIONS IN THE PAST FIVE YEARS (2021-2025)

Suvorov, V., Solé, R. & Saakian, D. B. (2025). *Geometric phase in the Crow–Kimura model of molecular evolution on dynamic environments*. Physical Review E 112(5): 054409.

Hu, W., Cui, L., Delgado-Baquerizo, M., Solé, R., Kéfi, S., Berdugo, M., Xu, N. *et al*. (2025). *Causes and consequences of disordered hyperuniformity in global drylands*. Proceedings of the National Academy of Sciences of the U.S.A. 122(41): e2504496122.

Solé, R., Kempes, C. & Stepney, S. (2025). *Origins of life: the possible and the actual*. Philosophical Transactions of the Royal Society B 380.

Solé, R. & De Domenico, M. (2025). *Bifurcations and phase transitions in the origins of life*. Philosophical Transactions of the Royal Society B 380: 20240295.

Maull, V., Aguadé-Gorgorió, G., de Lorenzo, V. & Solé, R. (2025). *Synthetic horizontal gene transfer for ecosystem restoration*. bioRxiv 2025.09.23.678013.

Pla-Mauri, J. & Solé, R. (2025). *Engineering basal cognition: minimal genetic circuits for habituation, sensitization, and massed–spaced learning*. bioRxiv 2025.09.09.674925.

Saavedra, S., Yang, Y., Kempes, C. P., Long, C., Solé, R., Yoshino, T. & Angulo, M. T. (2025). *Linking power, efficiency, and bifurcations in consumer–resource systems*. bioRxiv 2025.07.14.664758.

Pla-Mauri, J. & Solé, R. (2025). *A minimal genetic circuit for cellular anticipation*. bioRxiv 2025.04.22.649979.

Solé, R., Conde-Pueyo, N., Pla-Mauri, J., Garcia-Ojalvo, J., Montserrat, N. *et al*. (2024). *Open problems in synthetic multicellularity*. npj Systems Biology and Applications 10(1): 151.

Solé, R., Maull, V., Amor, D. R., Mauri, J. P. & Núria, C. P. (2024). *Synthetic ecosystems: From the test tube to the biosphere*. ACS Synthetic Biology 13(12): 3812–3826.

Sánchez-Fibla, M., Moulin-Frier, C. & Solé, R. (2024). *Cooperative control of environmental extremes by artificial intelligent agents*. Journal of the Royal Society Interface 21(220): 20240344.

Solé, R., Kempes, C. P., Corominas-Murtra, B., De Domenico, M., Kolchinsky, A. *et al*. (2024). *Fundamental constraints to the logic of living systems*. Interface Focus 14(5): 20240010.

Deng, J., Cordero, O. X., Fukami, T., Levin, S. A., Pringle, R. M. & Solé, R. (2024). *The development of ecological systems along paths of least resistance*. Current Biology 34(20): 4813–4823.e14.

Aguadé-Gorgorió, G., Anderson, A. R. A. & Solé, R. (2024). *Modeling tumors as complex ecosystems*. iScience 18.

Solé, R. (2024). *Nonequilibrium dynamics in conservation biology: scales, attractors and critical points*. Biological Conservation 294: 110601.

Maull, V., Pla-Mauri, J., Conde-Pueyo, N. & Solé, R. (2024). *A synthetic microbial Daisyworld: planetary regulation in the test tube*. Journal of the Royal Society Interface 21(211): 20230585.

Kéfi, S., Génin, A., Garcia-Mayor, A., Guirado, E., Cabral, J. S., Berdugo, M. *et al*. (2024). *Self-organization as a mechanism of resilience in dryland ecosystems*. Proceedings of the National Academy of Sciences of the U.S.A. 121(6): e2305153121.

Long, C., Deng, J., Nguyen, J., Liu, Y. Y., Alm, E. J., Solé, R. & Saavedra, S. (2024). *Structured community transitions explain the switching capacity of microbial systems*. Proceedings of the National Academy of Sciences of the U.S.A. 121(6): e2312521121.

Maull, V. & Solé, R. (2024). *Biodiversity as a firewall to engineered microbiomes for restoration and conservation*. Royal Society Open Science 11(6): 231526.

Piñero, J., Solé, R. & Kolchinsky, A. (2024). *Optimization of nonequilibrium free energy harvesting illustrated on bacteriorhodopsin*. Physical Review Research 6(1): 013275.

Seoane, L. F. & Solé, R. (2023). *How Turing parasites expand the computational landscape of digital life*. Physical Review E 108(4): 044407.

Aguadé-Gorgorió, G., Costa, J. & Solé, R. (2023). *An oncospace for human cancers*. BioEssays 45(5): 2200215.

Arsiwalla, X. D., Solé, R., Moulin-Frier, C., Herreros, I., Sánchez-Fibla, M. *et al*. (2023). *The morphospace of consciousness: three kinds of complexity for minds and machines*. NeuroSci 4(2): 79–102.

Solé, R. V. (2023). *Do plants have the cognitive complexity for sentience?* Animal Sentience 8(33): 18.

Solé, R. & Levin, S. (2022). *Ecological complexity and the biosphere: the next 30 years*. Philosophical Transactions of the Royal Society B 377(1857): 20210376.

Maull, V. & Solé, R. (2022). *Network-level containment of single-species bioengineering*. Philosophical Transactions of the Royal Society B 377(1857): 20210396.

Vidiella, B. & Solé, R. (2022). *Ecological firewalls for synthetic biology*. iScience 25(7).

Solé, R. (2022). *Revisiting Leigh Van Valen's "A new evolutionary law" (1973)*. Biological Theory 17(2): 120–125.

Bonforti, A. & Solé, R. (2022). *Unicellular–multicellular evolutionary branching driven by resource limitations*. Journal of the Royal Society Interface 19(191): 20220018.

Solé, R. & Seoane, L. F. (2022). *Evolution of brains and computers: the roads not taken*. Entropy 24(5): 665.

Piñero, J., Redner, S. & Solé, R. (2022). *Fixation and fluctuations in two-species cooperation*. Journal of Physics: Complexity 3(1): 015011.

Aguadé-Gorgorió, G., Kauffman, S. & Solé, R. (2022). *Transition therapy: tackling the ecology of tumor phenotypic plasticity*. Bulletin of Mathematical Biology 84(1): 24.

Berdugo, M., Vidiella, B., Solé, R. V. & Maestre, F. T. (2022). *Ecological mechanisms underlying aridity thresholds in global drylands*. Functional Ecology 36(1): 4–23.

Fraser, P., Solé, R. & De las Cuevas, G. (2021). *Why can the brain (and not a computer) make sense of the liar paradox?* Frontiers in Ecology and Evolution 9: 802300.

Solé, R., Sardanyés, J. & Elena, S. F. (2021). *Phase transitions in virology*. Reports on Progress in Physics 84(11): 115901.

Antó, J. M., Martí, J. L., Casals, J., Bou-Habib, P., Casal, P., Fleurbaey, M. *et al*. (2021). *The planetary wellbeing initiative: pursuing the sustainable development goals in higher education*. Sustainability 13(6): 3372.

Solé, R. & Aguadé-Gorgorió, G. (2021). *The ecology of cancer differentiation therapy*. Journal of Theoretical Biology 511: 110552.

Duran-Nebreda, S., Pla, J., Vidiella, B., Piñero, J., Conde-Pueyo, N. & Solé, R. (2021). *Synthetic lateral inhibition in periodic pattern forming microbial colonies*. ACS Synthetic Biology 10(2): 277–285.

Guillamon, A., Sardanyés, J., Maull, V., Conde-Pueyo, N. & Solé, R. (2021). *Engineering self-organized criticality in living cells*. Nature Communications.

Workshop organization

2022 – Co-Organiser of the Workshop "Origins of life: the possible and the actual", https://www.santafe.edu/events/origins-life-possible-and-actua
Santa Fe Institute, New Mexico, USA.

Theme issue (2025) available at: https://royalsocietypublishing.org/rstb/article/380/1936/20240281/235158/Origins-of-life-the-possible-and-the-actualOrigins

2021 – Co-Organiser of the Workshop "Ecological complexity and the biosphere: the next 30 years", Santa Fe Institute, New Mexico, USA.

Theme issue (2022) available at: https://royalsocietypublishing.org/rstb/article/377/1857/20210376/108993/Ecological-complexity-and-the-biosphere-the-next

2017 – Co-Organiser of the Workshop "Liquid brains, solid brains", Santa Fe Institute, New Mexico, USA.

Theme issue (2019) available at: https://royalsocietypublishing.org/doi/full/10.1098/rstb.2019.0040

2016 – Co-Organiser of the Workshop "The major synthetic evolutionary transitions", Santa Fe Institute, New Mexico, USA.

Theme issue available at: https://royalsocietypublishing.org/rstb/article/371/1701/20160175/22981/The-major-synthetic-evolutionary

2013 – Co-Organiser of the "ICREA Conference on the evolution of multicellularity", Biomedical Research Park (PRBB), Barcelona, Spain.

C.3. Funded research projects

Reference	Project Title	Funding Source	Amount (Euros)	Period	Role of the IP	Status
PID2023-152129NB-I00	PUNTOS DE INFLEXION EN LOS ECOSISTEMAS SINTETICOS DE COOPERADORES	Agencia Estatal Investigación	170.000	2024-2027	PI	Ongoing
PID2019-111680GB-I00	CRITICALIDAD SINTETICA	Agencia Estatal Investigación	169,400	2020-2023	Single PI	Evaluated
PR01018-EC-H2020-FET-Open	MADONNA	FET EU H2020	313,500	2018-2021	PI	Evaluated
FIS2015-67616	Statistical Physics of Synthetic Transitions	MINECO	68,000	2016-2019	Single PI	Evaluated
no - reference	Biological Computation	Fundación Botín Santander Bank	1.625,000	2010-2019	Single PI	Evaluated
FIS2012-39288	Física estadística de cánceres inestables genómicamente	MINECO	24,040	2013-2015	Single PI	Evaluated
294294	Distributed Computation in Synthetic Cellular Consortia	ERC Advanced Grant	2,764,000	2012-2017	Single PI	Evaluated
FIS2009-12365	Computación, replicación y rotura de simetría en sistemas protocelulares	MINISTERIO DE CIENCIA E INNOVACIÓN (MICINN)	89,540	2010-2012	Single PI	Evaluated
PR00607	Origins of innovation in tinkered networks	JAMES S.MCDONNELL FOUNDATION	450,000	2007-2012	Single PI	Evaluated
43312	Regulatory control networks of synthetic lethality	EUROPEAN COMMUNITY, FP6	222,000	2007-2010	Single PI	Evaluated

2035	Programmable Artificial Cell Evolution	EUROPEAN COMMUNITY, FP6	236,333	2004-2008	Single PI	Evaluated

Dissemination and outreach (selected)

- Curator, *The Invention of Time*, science exhibition (December 2025-September 2027). https://museuciencies.cat/en/exposicio_temporal/la-invencio-del-temps/
- Curator, *BRAIN(S)*, Centre de Cultura Contemporània de Barcelona (CCCB) (July–December 2022). The exhibition has been in place afterwards in Madrid, Donosti, Zaragoza and Sevilla (finising 2026) https://www.cccb.org/en/exhibitions/file/brains/237851
- Curator, Barcelona Science Biennale (February 2019 and June 2021). https://www.biennalciutaticiencia.barcelona/en/biennial/previous-editions/2019-edition https://www.biennalciutaticiencia.barcelona/es/la-biennal/ediciones-anteriores/edicion-2021
- Science advisor of the exhibiton *+Humans*, CCCB Barcelona (2015) https://www.cccb.org/ca/exposicions/fitxa/-humans/129032

Media and Public Broadcasts (TV/Radio/Online)

- Public discussion with Michael Levin, USA (December 2025).
- *The Space of Cognitions*, with Sean Carrol in *Mindscape*, USA (May 2023).https://www.preposterousuniverse.com/podcast/2024/01/01/260-ricard-sole-on-the-space-of-cognitions/
- *Virus, Ecosystems and Pandemic*, public broadcast (May 2020).

Contracts, technological or transfer merits

Participation as Principal Investigator, institution: Universitat Pompeu Fabra

Reference: AL02015
Title: Colaboración en materia de apoyo a la Transferencia Tecnológica en el campo de la biotecnología.
Funding agency: FUNDACIÓN MARCELINO BOTÍN
Date of start and end: 01/01/2015- 31/12/2019 Total amount: 1.125.000€

Reference: AL11209
Title: Convenio de colaboración en materia de apoyo a la transferencia tecnológica en el campo de la biotecnología, prof. Ricard Solé.
Funding agency: FUNDACIÓN MARCELINO BOTÍN

Date of start and end: 01/07/2009- 31/12/2010. Total amount: 660.000€

Patents:

Title: *Reprogrammable Multicellular Synthetic Circuits.*
Patent ID: MLS/CO-28289
Date: 16.08.10
Inventors: Macia J, Solé RV, Posas F, de Nadal E, Hohmann S.