Raw materials are essential to maintain and improve our quality of life, both for the construction of the materials and for the supply of energy. Their supply and their transformation are crucial to the economy of each country. Ensuring reliable and unhindered access to certain raw materials is therefore a growing concern at global level, as a result of the increased demand and probable lack of those traditionally used, and also for some environmental issues and policies that may result.

The European Commission has identified a list of raw materials so-called "critical" (http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52014DC0297) and not related to energy production (in practice , all but oil, gas etc.). This analysis is based on a forecast of demand in the short and medium term and the current extraction/production situation, therefore, without any consideration of eventual disruptive new technologies introduced in the interested sectors. E' importante distinguere la rilevanza economica di una materia prima dal suo rischio di approvvigionamento: ovvero, esistono materiali economicamente di alto valore ma che non sono a rischio scomparsa, e viceversa (e che quindi potrebbero notevolmente aumentare di costo col tempo). Inoltre, alcuni possono essere sostituiti, spesso a sfavore di alcune prestazioni, altri meno. Interessante invece identificare i ruoli dei paesi, in termini di copertura territoriale, da un punto di vista delle riserve di materie prime nel loro insieme: è la Cina che domina, specialmente se paragonato ad altri grandi paesi da un punto di vista di estensione geografica, come Stati Uniti, Russia e Brasile.

It is relevant to distinguish the economic importance of a raw material from its supply risk: that is, there are cost-high value materials but which are abundant, and viceversa (eventually increasing their cost significantly over time). In addition, some can be replaced, often paying for a reduced performance, some others not. It is then Interesting to identify the roles of the countries, in terms of coverage of their teritories, from the point of view of reserve/production of raw materials: China dominates, especially when compared to other large countries, such as US, Russia and Brazil.

This analysis suggests a reflection on the exploration and mining of the seabed, which has been recently addressed at the G7, and whose environmental impacts have been the focus of a large European scientific campaign (http://www.jpi-oceans.eu/ecological-aspects-deep-sea- mining). A more visionary reflection can be done about future developments on the production of new materials, which are becoming more and more innovative.

At the moment, some interesting simulations already predict to realize materials with unexpected features (http://www.nature.com/news/can-artificial-intelligence-create-the-next-wonder-material-1.19850).

Si possono ipotizzare, in un futuro non così lontano, anche materiali che si comportino come organismi, adattabili alle situazioni, e basati sull'assemblaggio di blocchi fondamentali, come i lego o i geni nel DNA, che sono caratterizzati da funzioni specifiche. Esistono già alcuni esempi promettenti in tal senso ma limitati in alcuni settori e molto specifici. Il primo materiale che può essere considerato "vivo" in questo senso furono le leghe a memoria di forma, ovvero quelle leghe metalliche che, senza nessun dispositivo aggiuntivo, cambiano forma in funzione delle condizioni ambientali esterne. Queste sono usate per l'apertura dei pannelli solari sui satelliti, lanciati a temperatura ambiente dalla Terra e una volta in orbita

esposti a basse temperature. In linea di principio lo sono anche i capelli femminili usati come sensori di umidità, che agiscono ad esempio come attuatori dei sistemi meccanici di misurazione nei musei. In poche parole, materiali che si comportano come sensori, accumulatori, attuatori ecc., senza bisogno di dispositivi aggiuntivi o di circuiti elettronici, reagendo alle condizioni ambientali con funzioni adattate alle situazioni.

In a not so distant future, materials that behave like organisms and based on the assembly of building blocks, like Lego or genes in DNA, can be foreseen too. Some promising examples of this kind of materials are already available, but limited in some sectors and still very specific. The first material that can be considered "alive" within this approach are the shape memory alloys: metal alloys that, without any additional device, change shape according to external environmental conditions. These are used for the opening of the solar panels on satellites, launched from Earth at room temperature and once in orbit exposed to low temperatures. In a few words, materials that behave as sensors, accumulators, actuators etc., without the need of additional electronic circuits or devices, reacting to environmental conditions with functions adapted to the situations.

Quantum mechanical simulations, the recent discoveries in genetics and eco-physiology, if integrated, could allow to pave the way towards the realization of such materials. It matters with a very complex problem, which requires both theoretical and operational developments, which could lead to a revolution in the theory of the description of the granularity of the lego-like blocks, as it was with the introduction of quantum theory in the early twentieth century, but especially in the industrial production system. In case of success of this innovative approach, the role of some raw materials may change, in favor of other more useful for the realization of systems that simulate the behavior of live organisms.

There are already examples of these systems in the so-called "synthetic biology", but a deeper dialogue between different communities, those of physicists and geneticists and biologists and engineers and others, is lacking: in order to find laws that can bridge biological aspects and those of theoretical physics and computing. In fact, the numerical simulations have not yet faced a measure of the complexity and the spatial configuration of the combination of atoms, as well as the theoretical approach seems not to have included the quantum interpretation of Bohm-Hiley, where in the classical formulas developed over the Einstein’era, an additional factor which takes into account features related to the information and functionality contained in the system, is introduced.

The future might therefore face a decentralization of production (through 3D or 4D printers) and a revolution in the supply/transformation of raw materials, but more drastically a generation of *stem* material, meaning they can adapt to the environment by responding with many different functions, can arise.

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