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Materials for Humanitas

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Human population has been increased more than 10 times since industrial revolution and it is expected to increase more than 20% in the next 80 years. Considering the currently used materials and production techniques, 1-fold increase in population causes 1.8-fold increase in demands. This increase leads to development of new materials and production techniques. Today, annual material consumption has exceeded 100 billion tons. As seen from Figure 1, minerals used in the construction industry constitute the largest share of this consumption. Even more interestingly, the proportion of waste materialsis greater than that used. As can be seen from Figure 1c, the share of recycled materials in total consumption is very low (around 8.54%).[1] From the economical point of view (Figure 1d), the service sector has the largest share among the economic sectors, but it is directly dependent to primary (agriculture, raw material production etc.) and secondary sectors (industrial production.[2]

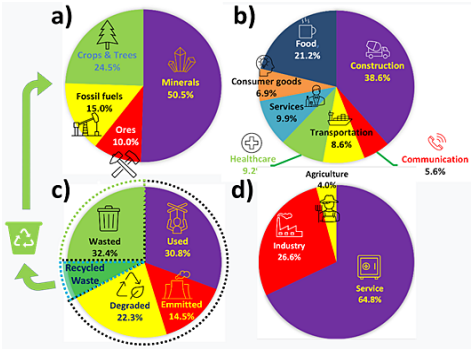

Fig. 1: Global material shares according to a) their origin, b) their application areas, and c) their fate.[1] d) global share of economic sectors according to gross domestic products.[2]

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Creating know-how in the primary and secondary economic sectors is of great importance for maintaining sustainable development. There are couple of ways to do this. First of all, waste material amount during production processes should be decreased or recycling of the materials should be increased. Increasing the amount of recycling is expected as a palliative solution in the short term. On the other hand, *sustainable raw materials* and *innovative production processes* those will reduce the amount of waste should be considered to maintain the future supply-demand balance. As a known fact, production technologies of the future should not produce waste and their products should be able to be processed and reused in a circular economy. From a material point of view, materials of the future should be multi-functional, affordable, sustainable, and adaptable to existing manufacturing processes and their updated versions. This transformation, which may seem futuristic for now,is of great importance for the future of humanity and is required for solving problems related to population and climate change.

One of the emerging approaches to overcome climatic obscurities, is reducing the dependence to fossil fuels. Nanomaterials and nanotechnology can offer alternative solutions for some sectors driven-by fossil-fuels such as energy storage and conversion, filtration, insulation etc. *Nano-crystalline celluloses* like cellulose nanofibers, cellulose whiskers or cellulose nanocrystals are important alternative nanomaterials for green nanocomposites.[3] *Carbonaceous 1D or 2D materials* including carbon nanotubes, fullerenes, carbon nanofibers, graphene etc. will also be key part of the industry in near future. These materials should be produced by using sustainable resources and processes.[4] *Perovskites* are also affordable and sustainable materials for energy storage and conversion or catalysis.[5] Although, 2D transition metal carbides or nitrides (*MXenes*) which were found by Gogotsi *et al*. are comparably new class of 2D materials, they quickly established themselves in the scientific community.[6] Combination of these materials with conventional classes of materials including metals, semi-conductors, ceramics, or polymers/copolymers will also offer new material structures. All of these novel structures will be the key part of the cutting-edge research areas such as flexible, stretchable and wearable electronics including circuits, sensors, capacitors, resistors, transistors, batteries.

As known, new materials create new technologies. Science has always been a guide for humanity. I believe that the scientific approach will again illuminate the way of civilization as always, especially in the age of technology.

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