17 Oct 2020: PIB Summary & Analysis

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1. New developments in bio-inspired materials for energy & biotechnology sector

Context:

Scientists from the Jawaharlal Nehru Centre for Advanced Science and Research (JNCASR), an autonomous institution of the Department of Science and Technology (DST), have developed a synthetic mimic of redox-active biological assemblies, with precise structure and dynamics that can be manipulated.

Details:

- Scientists have developed a synthetic material that mimics the dynamic capability of living organisms to adapt to new environments by utilizing simple natural design principles to create complex networks.
- The new materials developed opens new avenues for smart materials because of their dynamic and adaptive nature.
- Hence, **they would be useful as recyclable polymers for the energy and biotechnology sector.**
- The scientists have shown that such bio-inspired structures are formed by assembling transient dormant monomeric molecules (basic units of polymers) by coupling them to a reduction-oxidation reaction network.
- They form a chemical entity called supramolecular polymers with strikingly dynamic properties.
- The properties arise because they are connected by non-covalent bonds, which are reversible bonds that hold their chains together.
- These dynamic properties open up prospects of many new applications of these materials.

Background:

- Reduction–oxidation (redox) processes are central to many biological functions.
- Cellular functions like growth, motility, and navigations depend on the assembling of biopolymers whose dynamic behaviour is linked to a reduction-oxidation (redox) reaction in which enzymes are involved.
- Nature synthesizes these biopolymers controlling their size and dispersity to regulate their functions, without which their sophistication and efficacy are affected.
- Researchers have been trying to mimic such complex structural control based on chemical reaction networks.

2. Devitrification

Context:

Scientist's demystification of the transformation of glass to crystal can help dispose of liquid nuclear waste safely.

Background:

- Glass is a non-crystalline, often transparent amorphous solid which is mostly formed by the rapid cooling of its molten form.
- However, under certain conditions, during its formation, the molten glass may rebel and transform into a crystal – the more stable state, an avoidable process called devitrification.
- However, the process of devitrification remains poorly understood as this process can be extremely slow, and this makes it difficult to study it.

Significance of the study:

- Scientists have now visualized devitrification in an experiment, thus taking a step closer to understanding it.
- This could help avoid devitrification in processes of **pharma industries** – a sector in which dodging this is of paramount importance.
- This is because an amorphous drug dissolves faster than after devitrification, and ensuring that it remains amorphous is therefore essential during storage.

Details of the study:

- Using real-time monitoring of the particles with an optical microscope and machine learning methods to determine subtle structural features hidden in the glass, the researchers identified a parameter called 'softness', which determines the extent of devitrification.
- They found that regions in the glass which had particle clusters with large "softness" values were the ones that crystallized and that "softness" was also sensitive to the crystallization route.
- The team suggests that techniques to tune "softness" by introducing impurities may help realize long-lived glass states, which has numerous technological applications.
- The research published in the journal 'Nature Physics' can also help in the vitrification of liquid nuclear waste as a solid in a glass matrix to safely dispose it deep underground and prevent hazardous materials from leaking into the environment.