Peptide-Based Piezoelectric Biomaterials

Prelims: *Current events of national and international importance | Science & Technology*

Why in News?

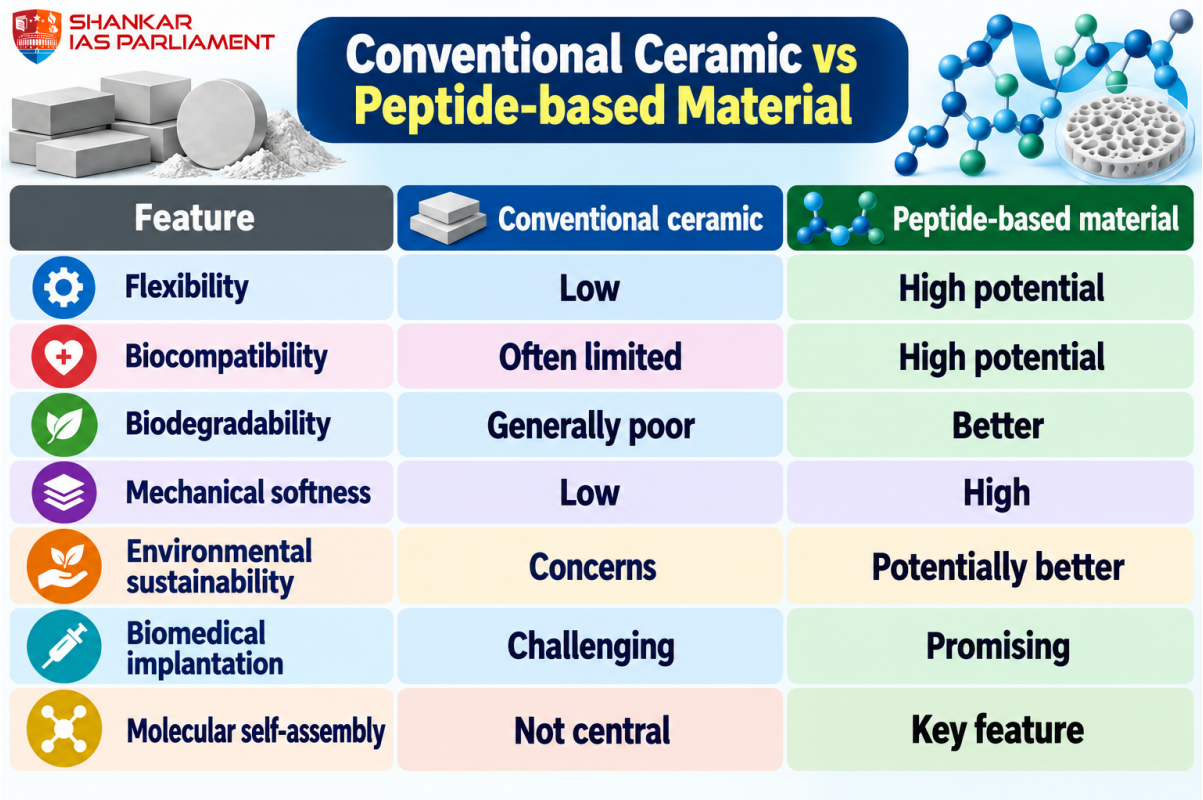
Recently, "Researchers at CeNS Bengaluru, IISER Kolkata, and JNCASR Bengaluru have developed a peptide-based piezoelectric biomaterial with potential biomedical applications."

- **Piezoelectricity –** It is the phenomenon where mechanical stress generates electric charge in certain solids such as ceramics, crystals, and biological materials (DNA, bone, proteins).
- The term originates from Greek words meaning "press" and "amber," historically linked to electricity.
- **New findings –** While the chemical composition stays the same, differences in molecular arrangement change the material's functionality.
- **Key Observations**
- When dissolved in water, peptide molecules form nanofibers and show no detectable piezoelectric response.
- With about 1% co-solvent, peptide molecules reorganise into a supramolecular structure that displays a strong piezoelectric response.

Self-assembly - *Peptide molecules form ordered supramolecular structures on their own.*

- The same peptide, assembled differently, exhibits distinct electrical properties.
- This finding highlights the essential relationship between structure and function in biomaterials.
- Researchers employed advanced nanoscale characterisation techniques, including the following:
    - Atomic Force Microscopy (AFM) – This technique examines surface and topographical features at the nanoscale.
    - Field Emission Scanning Electron Microscopy (FESEM) – It provides high-resolution imaging of nanostructures.
    - Computational simulations – These simulations help elucidate molecular organisation and interactions.
- **Potential Uses**
    - Implantable medical sensors

- Biosensors
- Electronic skin
- Wearable health-monitoring devices
- Energy harvesting



Feature	Conventional ceramic	Peptide-based material
Flexibility	Low	High potential
Biocompatibility	Often limited	High potential
Biodegradability	Generally poor	Better
Mechanical softness	Low	High
Environmental sustainability	Concerns	Potentially better
Biomedical implantation	Challenging	Promising
Molecular self-assembly	Not central	Key feature

- **Mechanism –** Natural body movements, such as heartbeat, breathing, and walking, cause mechanical deformation.
- Peptide piezoelectric materials convert this mechanical deformation into electrical energy.
- Thus, such materials could potentially help develop self-powered, low-energy biomedical devices.

Reference

PIB | Piezoelectricity

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