Pathways to Decarbonizing Electric Power Generation :
Challenges and Opportunities for Energy Materials and Carbon Capture

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Transition pathways into a sustainable energy economy pose serious challenges with difficult choices, as energy policies also impact the environment, food and water production, and even mass migrations. Our dependence on fossil fuels results in anthropogenic emissions of nearly 37 $GtCO_2$/yr and is strongly linked to climate change and global warming. This poses an existential and imminent threat to our carbon-constraint planet and the welfare of future generations.

Transforming major segments of the global energy economy to clean and sustainable energy sources requires a multi-prong strategy as well as technological diversity to assure energy security while tackling climate change and global warming. Critical components of the strategy demand sharp increase in renewable energy capacity, rapid build-up of scalable energy storage technologies, phasing out air-based combustion of fossil fuels while developing oxygen-based conversion technologies, and lastly, pricing of carbon emissions. At the same time, carbon capture and storage (CCS) technologies must be deployed at the gigaton scale. Progress in these areas is critically dependent upon enhancing materials properties and performance. Hence, innovations in materials will be central to the collective effort in meeting our energy demands while reducing and capturing CO_2 emissions.

The talk will start by framing the global energy and electricity landscapes in the context of CO_2 emissions, highlight the immense magnitude of global challenges to mitigate climate change, and review various technological and materials options for CO_2 capture, energy storage and electricity production via oxygen-based power generation from fossil fuels in high temperature fuel cells. Time permitting, examples will be provided of how nanostructuring tools can help improve the performance of energy conversion and storage systems by atomic scale design of grain boundaries as well as surface and interface engineering of functional oxides.