FRONTIERS OF CARBON CAPTURE, UTILIZATION AND STORAGE

Session co-chairs:
A.-H. Alissa Park (Columbia University, USA) and Davide Mattia (University of Bath, UK)

With the rapid industrial growth worldwide, the global energy demand is increasing at an unprecedented rate. While we continue to improve the efficiencies of energy conversion systems and develop renewable energy sources, the amount of fossil fuels being used to support the ever growing population is tremendous. Fossil energy sources such as coal, natural gas and oil are high in energy densities and still relatively low in price, and thus, the use of fossil fuels will unfortunately continue into the foreseeable future. We will eventually run out of these fossil fuels, but at this time, we are running out of the environment even faster. In particular, the increase CO_2 concentration in atmosphere has been suggested to cause climate change, and thus, there has been significant efforts to develop technologies to manage anthropogenic carbon emissions.

Carbon capture, utilization and storage (CCUS) is one of the most urgent technological and societal challenges faced by humanity because of the extreme scales of CO_2 emission (both physical and temporal). The global CO_2 emission in 2014 was 32 Gt, and reports including the 2013 report by Intergovernmental Panel on Climate Change suggest that we have already past the point of no return indicating not only the current emission should be reduced and stopped but also the past emissions should be rectified via negative emission.

CCUS technologies have often been developed independently of one another, and this has resulted in complex and economically challenged designs without sufficient discussion on the societal impacts of their implementations. Thus, truly multi-disciplinary, multi-dimensional discussion is critical to provide transformative research directions in CCUS. The session on CCUS will effectively cross the boundaries of the natural sciences, engineering, and the social and economic sciences to discuss new understanding, theories, models and technologies as well as assessment tools for the developed CCUS technologies and their implementation plans for global communities. Discussion topics will include a full range of materials studies involving chemical and physical interactions with CO_2 at multi- time and spatial scales ranging from molecular level to geological scales for CCUS as well as CO_2 conversion to chemicals and fuels. Their interrelations with the studies of science policy, life cycle analysis and economics will also be discussed.

The first speaker, Krista Walton, will set the stage for novel materials research for carbon capture. She will provide the review of various CO_2 capture materials in terms of their capabilities and limitations. The second speaker, Deepak Pan, will discuss recent advances in biochemical conversion of CO_2 to chemicals. The third speaker, Sebastian Teir, will discuss carbon dioxide storage and utilization. Finally, Meagan Mauter, will talk about optimizing integration electricity generation, water treatment, and carbon capture and storage processes in coal-fired generating facilities.