Fighting Cancer with Nanoparticle Medicines: The Nanoscale Matters!

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Abstract:
Papyrus writings from 1600-1500 BC describe cancer and attempts at its treatment. Today, centuries later, cancer remains a devastating disease. Given the long history of difficulties in developing cancer therapies, why is there excitement about nanoparticle medicine (nanomedicines) for fighting cancer? In this lecture, I will present the current understandings of why these engineered, nanosized medicines (that are highly multifunctional chemical systems) have the potential to provide "game changing" ways to treat cancer. The nanoscale matters. I will illustrate this point by demonstrating how physical insights at the nanoscale allow for the development of nanoparticles that can function as intended in animals and humans. The data from humans will be used to show how we have translated two independent nanoparticle cancer therapeutics from laboratory curiosities to experimental therapeutics in human clinical trials.

Technical Lecture: New Heterogeneous Catalysts for Converting Sugars in Aqueous Media

Abstract:
The isomerization of glucose into fructose is a large-scale reaction for the production of high-fructose corn syrup, and recently, is being considered as an intermediate step in the possible route of biomass to fuels and chemicals. Here, it is shown that a large pore zeolite that contains tin (Sn-Beta) is able to isomerize glucose to fructose in aqueous media with high activity and selectivity. Specifically, a 10 wt% glucose solution containing a catalytic amount of Sn-Beta (1:50 Sn:glucose molar ratio) gives product yields of approximately 46% (w/w) glucose, 31% (w/w) fructose, and 9% (w/w) mannose after 30 and 12 minutes of reaction at 383 K and 413 K, respectively. This reactivity is achieved also when a 45wt% glucose solution is converted. The Sn-Beta catalyst can be used for multiple cycles, and the reaction stops when the solid is removed, clearly indicating that the catalysis is occurring heterogeneously. With isotopically labeled glucose, it is demonstrated that the isomerization reaction catalyzed by Sn-Beta in water proceeds by way of an intramolecular hydride shift, confirming that framework tin centers in Sn-Beta act as Lewis acids in aqueous media. The active site is shown to be Sn that has three bonds to framework oxygen atoms, and reaction rates are strongly dependent on the hydrophobicity of the molecular sieve. The Sn-Beta catalyst is able to perform the isomerization reaction in highly acidic, aqueous environments with equivalent activity and product distribution as in media without added acid. This enables Sn-Beta to couple isomerizations with other acid-catalyzed reactions, including hydrolysis/isomerization or isomerization/dehydration reaction sequences, including starch to fructose and glucose to 5-hydroxymethylfurfural (HMF). Modifications of Sn-Beta (and Ti-Beta) have expanded the types of reactions that can be catalyzed. Some of those reactions include the conversion of glucose to mannose, glucose to sorbose and lactose to lactulose.