

*You are  
cordially invited  
to attend*

**The 40th Annual**

**Harry G. Fair**

**Memorial Lecture in  
Chemical Engineering  
2014**

**Thursday, March 13, 2014**

**Seminar – 2 p.m.**

**Room M-204**

**Sarkeys Energy Center  
100 East Boyd  
University of Oklahoma  
Norman, Oklahoma**

**Coffee and refreshments will  
be served.**

Accommodations on the basis of disabilities are available by calling (405) 325-5811.

The University of Oklahoma is an equal opportunity institution. 3/14

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## **Harry G. Fair Memorial Lecturers**

- 2014 Mark E. Davis, California Institute of Technology
- 2013 Alexis T. Bell, University of California, Berkeley
- 2012 Charles Zukoski, University of Illinois at Urbana-Champaign
- 2011 Peter C. Stair, Northwestern University
- 2010 Juan J. de Pablo, University of Wisconsin-Madison
- 2008 Donald R. Paul, University of Texas at Austin
- 2007 David Mooney, Harvard University
- 2007 John Prausnitz, University of California, Berkeley
- 2006 George Georgiou, University of Texas at Austin
- 2005 James A. Dumesic, University of Wisconsin
- 2004 Robert C. Armstrong, Massachusetts Institute of Technology
- 2003 Nicholas Peppas, University of Texas at Austin
- 2002 Richard C. Alkire, University of Illinois
- 2001 Ralph T. Yang, University of Michigan
- 2000 Enrique Iglesias, University of California, Berkeley
- 1999 George Stephanopoulos, Massachusetts Institute of Technology
- 1998 Stuart L. Cooper, University of Delaware
- 1997 Keith E. Gubbins, Cornell University
- 1996 H. Scott Fogler, University of Michigan
- 1995 Gary L. Haller, Yale University
- 1994 Christopher W. Macosko, University of Minnesota
- 1993 Larry V. McIntire, Rice University
- 1992 Dan Luss, University of Houston
- 1991 E. N. Lightfoot, University of Wisconsin
- 1990 George A. Samara, Sandia National Labs
- 1989 James Wei, Massachusetts Institute of Technology
- 1988 C. Judson King, University of California, Berkeley
- 1987 Eli Ruckenstein, SUNY Buffalo
- 1986 Stuart W. Churchill, University of Pennsylvania
- 1985 John M. Campbell, John M. Campbell & Co.
- 1984 Richard G. Askew, Phillips Chemical Co.
- 1983 B. H. Sellers, Sellers Chemical Co.
- 1982 Lynn T. Reed, Warren Petroleum Co.
- 1981 Robert S. Purgason, Perry Gas Processors
- 1980 A. B. Slaybaugh, Conoco Inc.
- 1979 Charles R. Perry, Perry Gas Cos.
- 1978 Raymond W. Lowe, E. I. DuPont de Nemours
- 1977 Laurance S. Reid, Ball-Reid Engineers Inc.
- 1976 Harry L. Blomquist Jr., Coastal States Gas Co.
- 1975 Stanley Learned, Phillips Petroleum Co.

**School of Chemical, Biological and Materials Engineering**  
College of Engineering  
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Norman, Oklahoma 73019-1004  
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## **The 40th Annual**

**Harry G. Fair  
Memorial Lecture in  
Chemical Engineering  
2014**



**Mark E. Davis**

Chemical Engineering  
California Institute of Technology  
Pasadena, California

***New Heterogeneous Catalysis  
for Converting Sugars  
in Aqueous Media***



## Harry G. Fair

Each year, a special lecture is given in memory of Harry G. Fair, an outstanding OU alumnus. Fair was born in Okmulgee, Oklahoma on June 3, 1916, and earned his bachelor of science degree in chemical engineering in 1939. He joined Phillips Petroleum Co. in 1939 and worked his way up to vice president for supply and transportation, with responsibility for worldwide exchange of crude oil and all transportation facilities. In 1966, Fair joined M.W. Kellogg Co. as executive vice president in charge of all engineering activities. He was named executive vice president of Coastal States Gas Corp. in 1971, a post he held until his death on July 27, 1974. A member of a number of professional societies and a licensed professional engineer, Fair was active in service to society and his alma mater.

This lecture is made possible by the Harry G. Fair Memorial Fund established by his widow, Jane Swift Fair. Arrangements for the lecture are made by the School of Chemical, Biological and Materials Engineering in OU's College of Engineering.

## New Heterogeneous Catalysis for Converting Sugars in Aqueous Media

### Mark E. Davis

Chemical Engineering  
California Institute of Technology  
Pasadena, California

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 45 wt% 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 ( $^1\text{H}$  and  $^{13}\text{C}$  MAS NMR spectroscopy) 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. Most importantly, 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).

## Mark E. Davis

Mark E. Davis is the Warren and Katharine Schlinger Professor of Chemical Engineering at the California Institute of Technology and a member of the Experimental Therapeutics Program of the Comprehensive Cancer Center at the City of Hope and the Jonsson Comprehensive Cancer Center at UCLA.

He has over 375 scientific publications, two textbooks and over 50 US patents. Professor Davis is a founding editor of *CaTTech* and has been an associate editor of *Chemistry of Materials* and the *AIChE Journal*.

He is the recipient of numerous awards, including the Colburn and Professional Progress Awards from the *AIChE* and the Somorjai, Ipatieff, Langmuir, Murphree and Gaden Prizes from the ACS. Professor Davis was the first engineer to win the NSF Alan T. Waterman Award. He was elected in the National Academy of Sciences Engineering in 1997, the National Academy of Sciences in 2006 and the Institute of Medicine of the National Academies in 2011.

Professor Davis, research efforts involve materials synthesis in two general areas; namely, zeolites and other solids that can be used for molecular recognition and catalysis, and polymers for the delivery of a broad range of therapeutics. He is the founder of Insert Therapeutics Inc. Calando Pharmaceuticals, Inc. a company that created the first RNAi therapeutic to reach the clinic for treating cancer, Avidity Nanomedicines and Innovia Biotech. He has been a member of the scientific advisory boards of Symyx (Nasdaq: SMMX) and Alnylam (Nasdaq: ALNY).

Professor Davis has achieved All American Status for Masters Track and Field in the 400, 200 and 100 Meter Dashes. He is the 400 Meter Dash World Champion for men of age 55-59.