Methanol oxidation on ferric molybdate (and all oxides?)

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In this talk I will discuss methanol oxidation to formaldehyde, focusing on $Fe_2(MoO_4)_3$, but including some other oxides. I will establish a number of 'rules' which dictate the excellent behaviour of ferric molybdate, including

i) *Surface* oxygen is the active species
ii) Most lattice oxygen can become active surface oxygen
iii) Preferential cation segregation occurs and is crucial for reaction efficiency
iv) The highest oxidation state is the selective one

I will then explore the nature of the active sites involved in the reaction and show that ensembles of Fe and Mo dictate the reactivity pattern, while isolated sites produce CO. Further, atomically-resolved STM (Scanning Tunnelling Microscopy), carried out on single crystal iron oxide surface dosed with Mo, indicates that the Mo likes to form trimer ensembles on the surface. See the figure below, the bright units are the Mo_3O_9 trimers.

Finally, if time permits, I will consider the possibility of a 'green' route to formaldehyde, using renewable hydrogen and recycled CO_2.