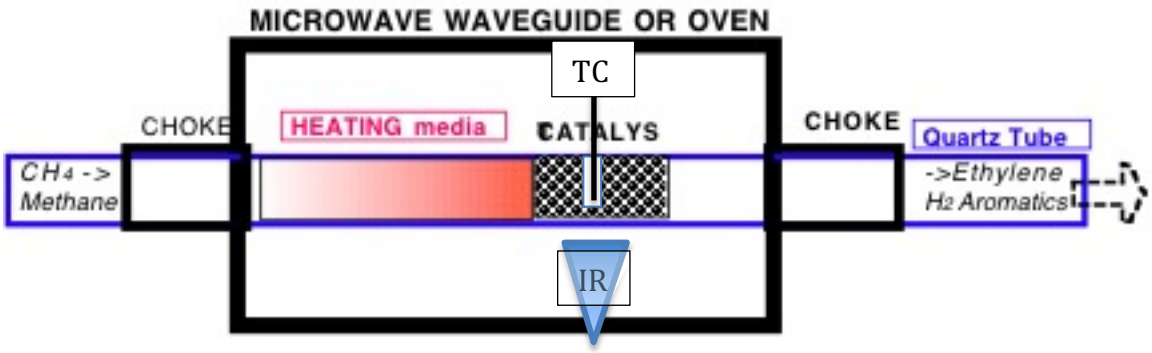
PRF report October 2018

This has been an excellent year in the progress of this research. We now have a permanent graduate student, Kaivalya Gawande, associated with this research. He has set up a flow system within a quartz reactor system that now has both gas chromatography, GC (by dosing), and continuous mass spectral analyses. Methane (99.999% with Ar) and helium flow control are provided by mass flow controllers. This system is fully able to characterize the potential products for the reaction of methane to ethylene and the other potential or claimed products from this reaction. We have synthesized the catalyst that has been claimed to maximize the production of ethylene from methane at 1300°C as was claimed in the initial Science paper (2014)[1]. Indeed, we have found that our version of this (Fe on silica) catalyst produces a single product at this temperature with conventional heating, i.e., from a tube furnace. The product yield is not too large but increases with temperature (measured by and decreasing methane flow rates. The mass spectral analyses are consistent with ethylene. The GC analyses are promising and we are working on developing the quantitative analyses for this dominant gaseous product. As soon as we feel comfortable with the quantitative analyses, we will move the reactor system into the microwave oven system. The Mass Spectrometer will enable us to do the isotopic labeling studies proposed.

CEM has donated a new microwave oven (2000W) for this research and microwave chokes have been installed to allow the same quartz reactor system to be inserted into the oven. Both infrared and thermocouple temperature measurements are available in this system. The thermocouple will be inserted into a quartz 1/16" insert into the reactor flow within the catalyst bed. The system diagram is show below:



1. Guo, X.G., et al., *Direct, Nonoxidative Conversion of Methane to Ethylene, Aromatics, and Hydrogen.* Science, 2014. **344**(6184): p. 616-619.