

# CAFFE Research Project

## Carbides for Future Fission Environments

### Accident Tolerant Fuels

### Clads

Zircalloy is an excellent material in normal operating conditions for LWRs.

In a LOCA situation, rapid & strongly exothermic reaction with steam.

Reduction in strength with temperature & irradiation growth is a limit on burn-up.

Main safety factor in design basis accidents



**Carbides for Future Fission Environments**  
New materials for cladding



Hi T steam tests on zircalloys  
[Y. Lee (KAIST)]

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## Aim

- Zr carbide based materials for high dpa operation
- MAX phase-like layered carbides - potentially machinable
- Good neutronics and resistant to radiation damage & corrosion

## Methods

### DFT calculations:

finite T free energies ZrC and other C binaries to provide input to phase diagram calculation  
defects, grain boundary interactions

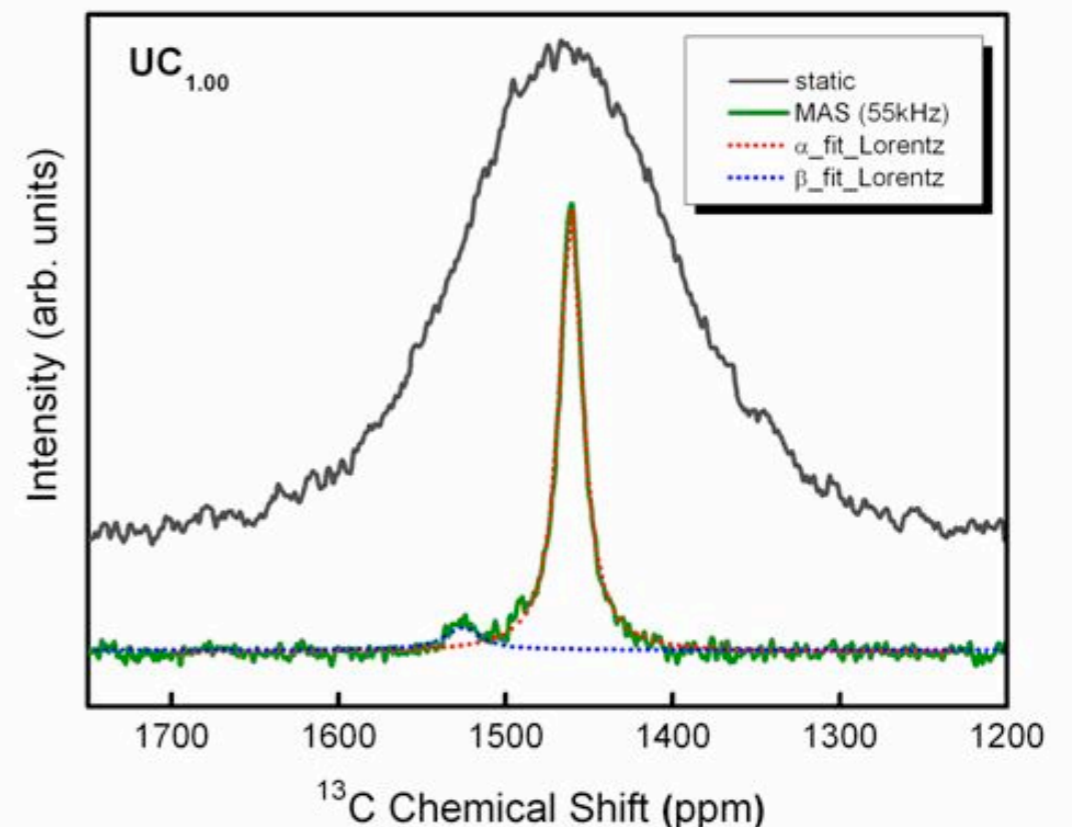
### Fabrication & Characterisation:

optimised preparation, radiation damage and steam corrosion effects

$^{13}\text{C}$  MASNMR, TEM, Physical properties

Irradiation, in situ irradiation & XRD [Uman/DCF]

MAS NMR 55kHz UC<sub>1.02</sub>



# CAFFE Research Project

Universities: Cambridge, Imperial, Manchester

Industrial: Westinghouse, NNL, Rolls-Royce

Facilities: NNUF Dalton Cumbria

Personnel: Ian Farnan, Paul Bristowe, Kevin Knowles  
Bill Lee, Mike Finnis, Ni Na, Denis Horlait  
Philip Frankel, Michael Preuss, Simon Pimblott

3 x PDRAs, 3 x PhD students, several Masters dissertations

Collaboration: CARAT (USDoE/Westinghouse), IL TROVATORE (H2020),  
FALSTAFF(H2020???)

International meeting: Accident Tolerant Materials  
Cambridge, summer 2018