

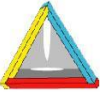
# **Deposition of volcanic ash in customised set-up for simulation of a turbine combustion chamber**

**C. Taltavull ,Y. Shams, K. A. Roberts, J. Dean, T.W. Clyne**

**18<sup>th</sup> June, 2014, Cambridge**

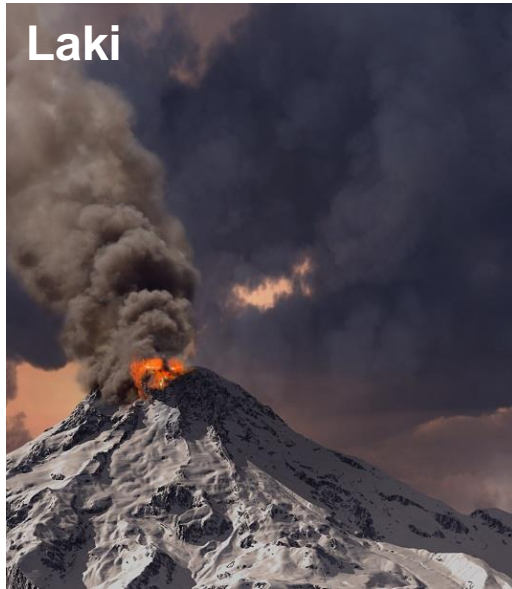


Engineering and Physical Sciences  
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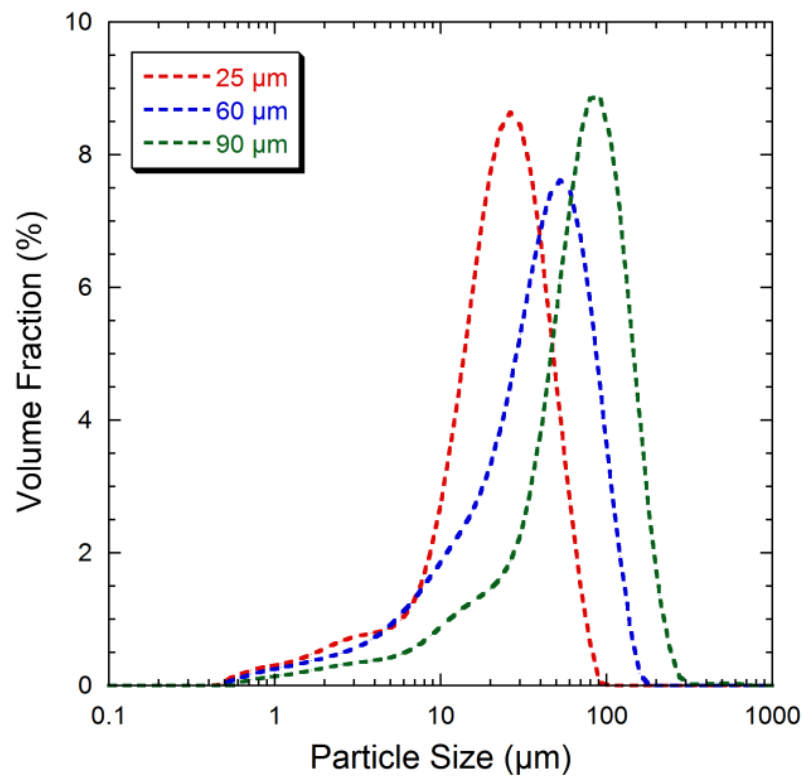
# 1. Selection of volcanic ash

- Particle Size
- Composition
- Crystalline/amorphous Content
- $T_g/T_m$

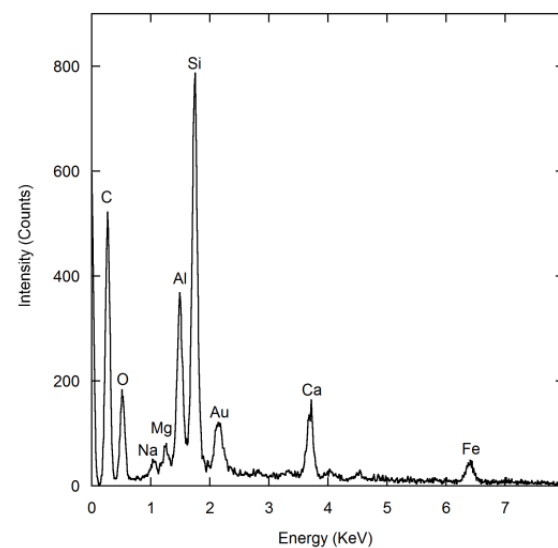
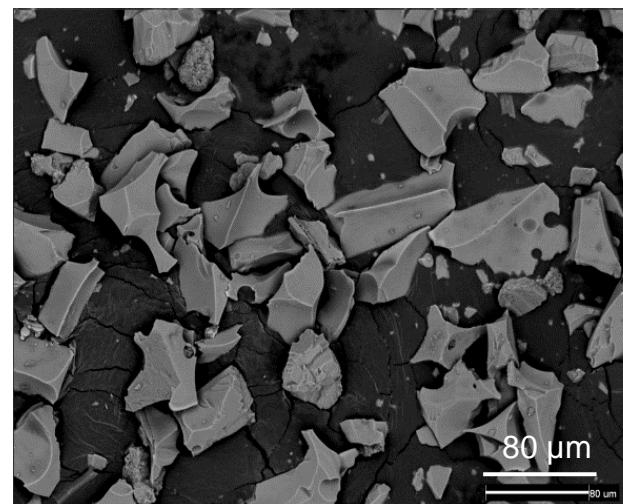


# 1. Selection of volcanic ash

## Particle Size: Sieving



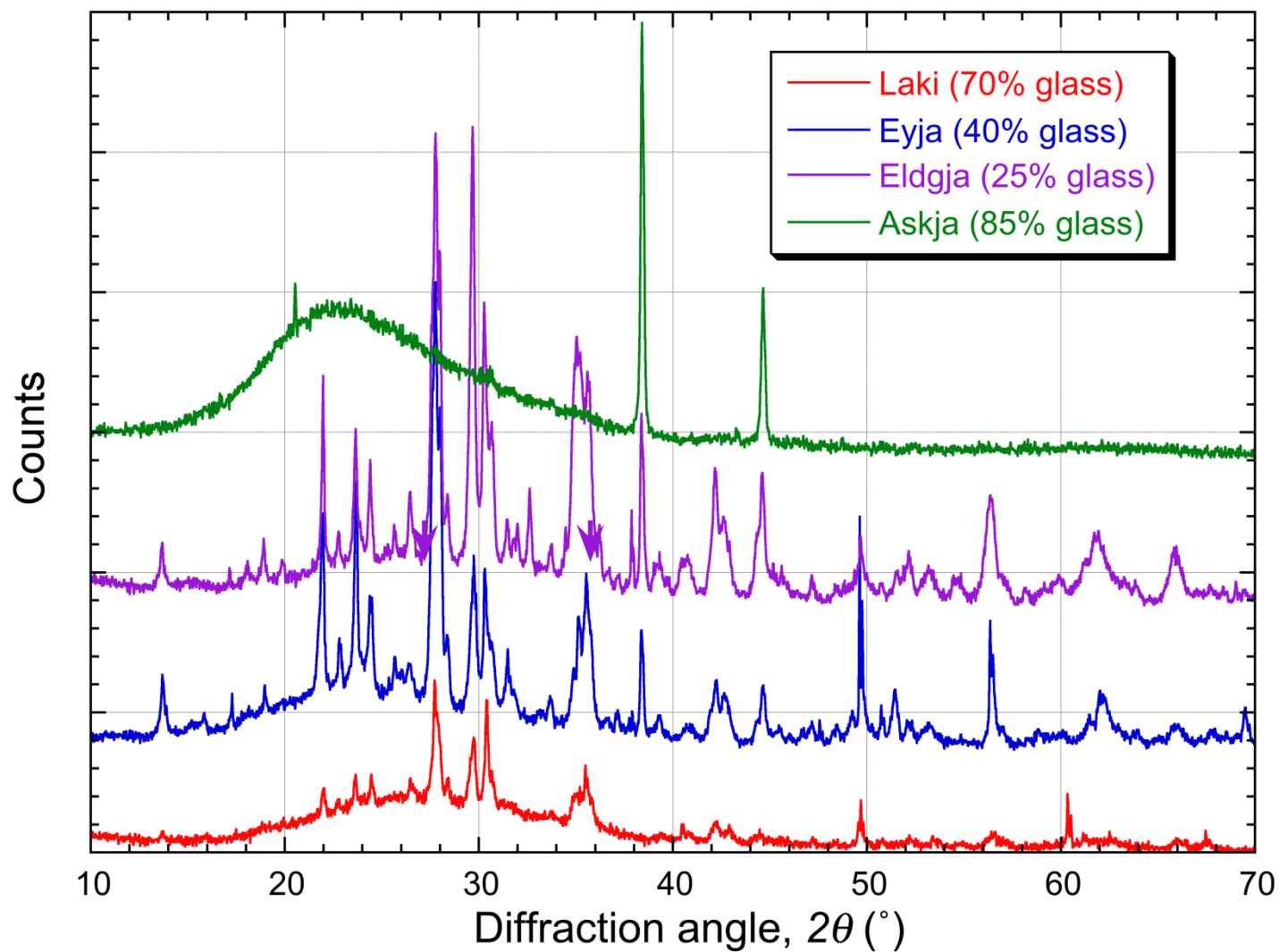
## Morphology and Composition: SEM/EDX





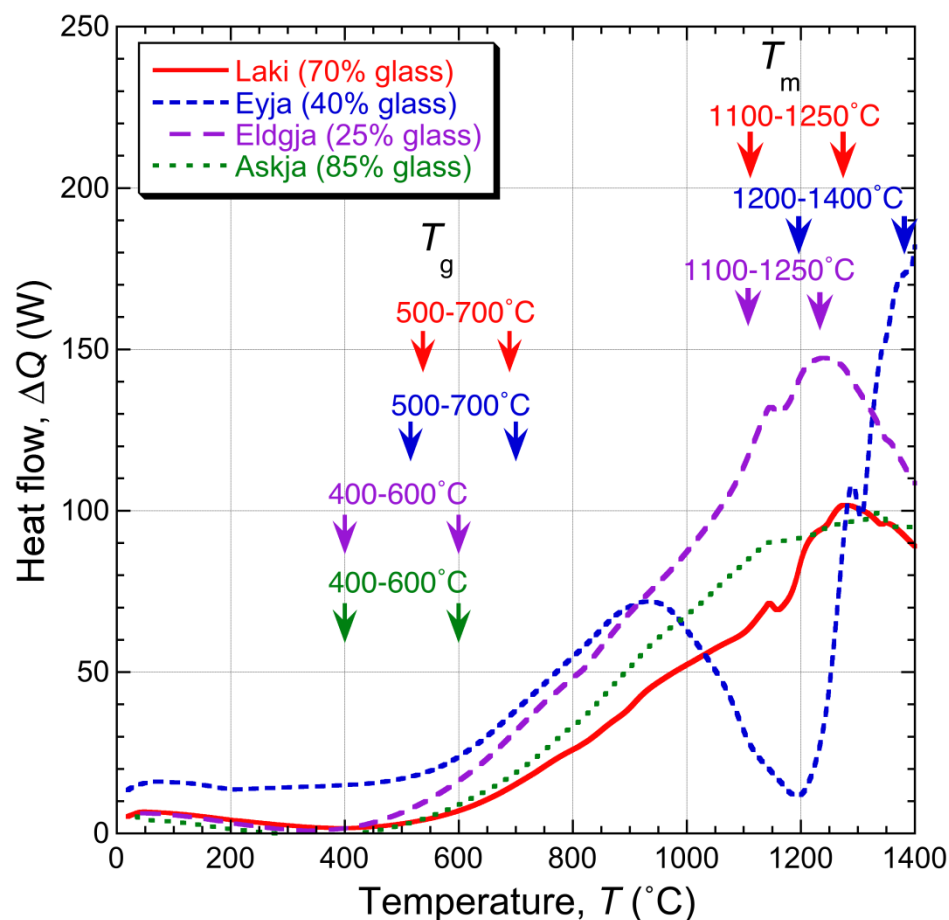
# 1. Selection of volcanic ash

## Crystalline/amorphous content: X- Ray

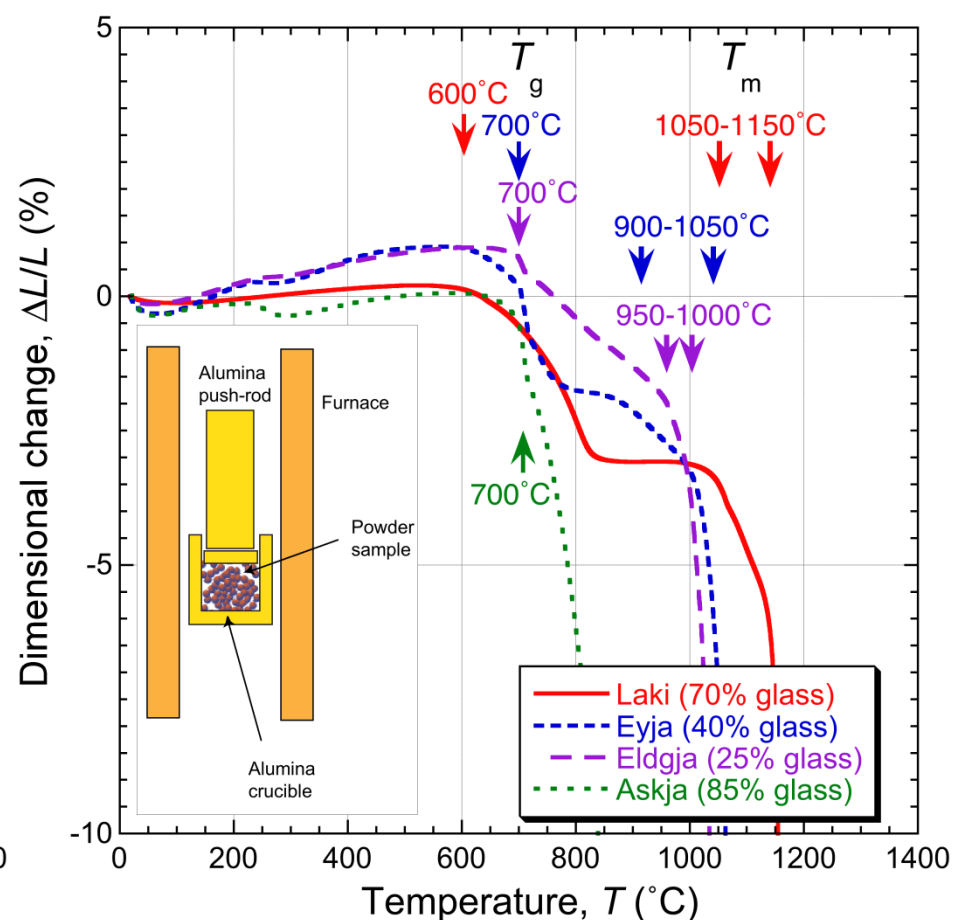


# 1. Selection of volcanic ash

## T<sub>g</sub> measurement



DSC Data

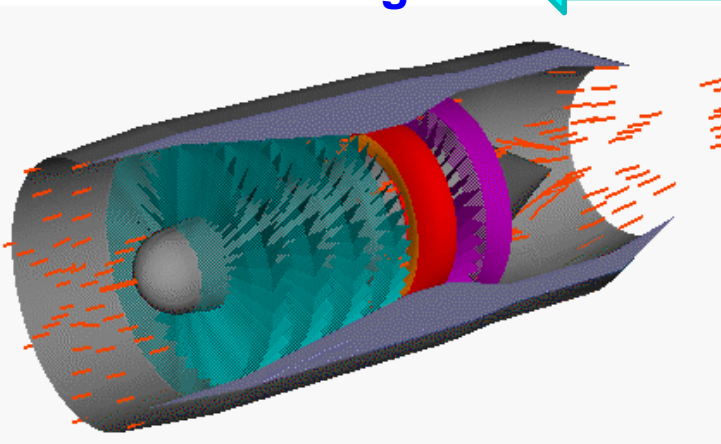


Densification monitoring  
(Dilatometry Data)

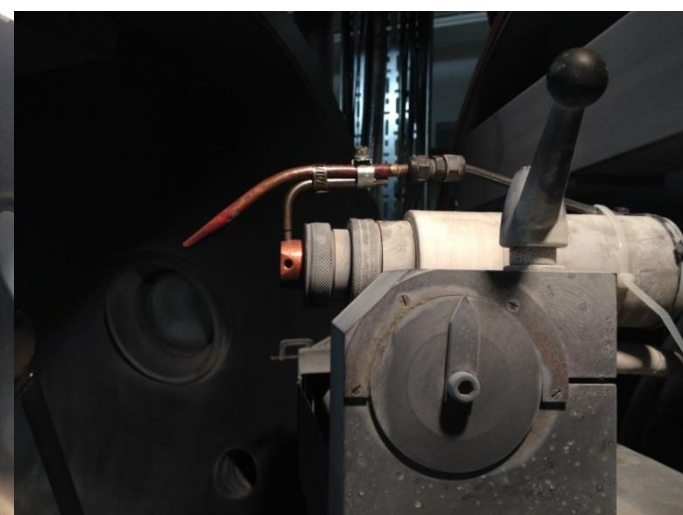
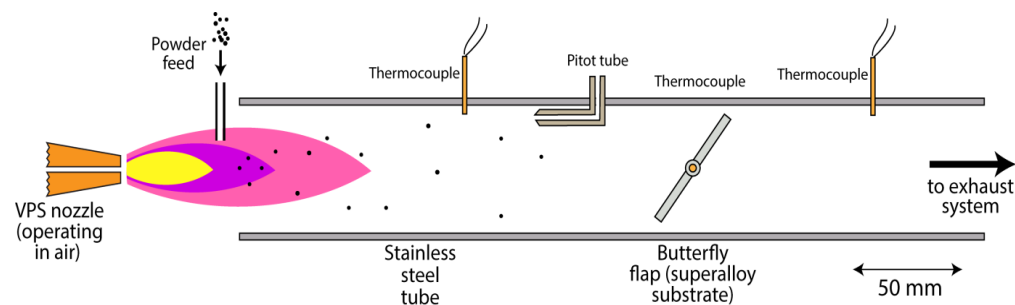


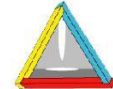
## 2. Customized Set-up

Jet-Engine



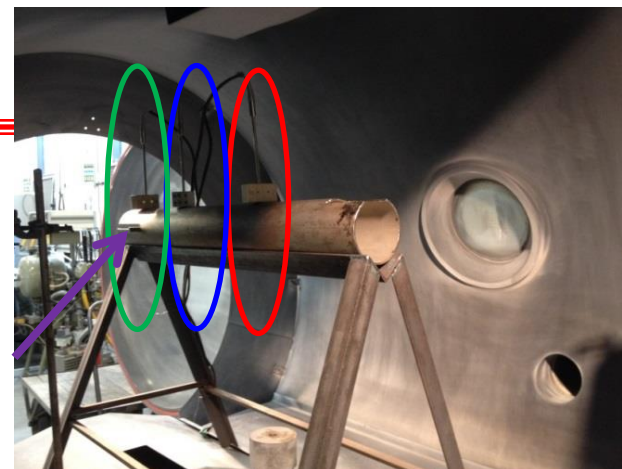
VPS customized set-up



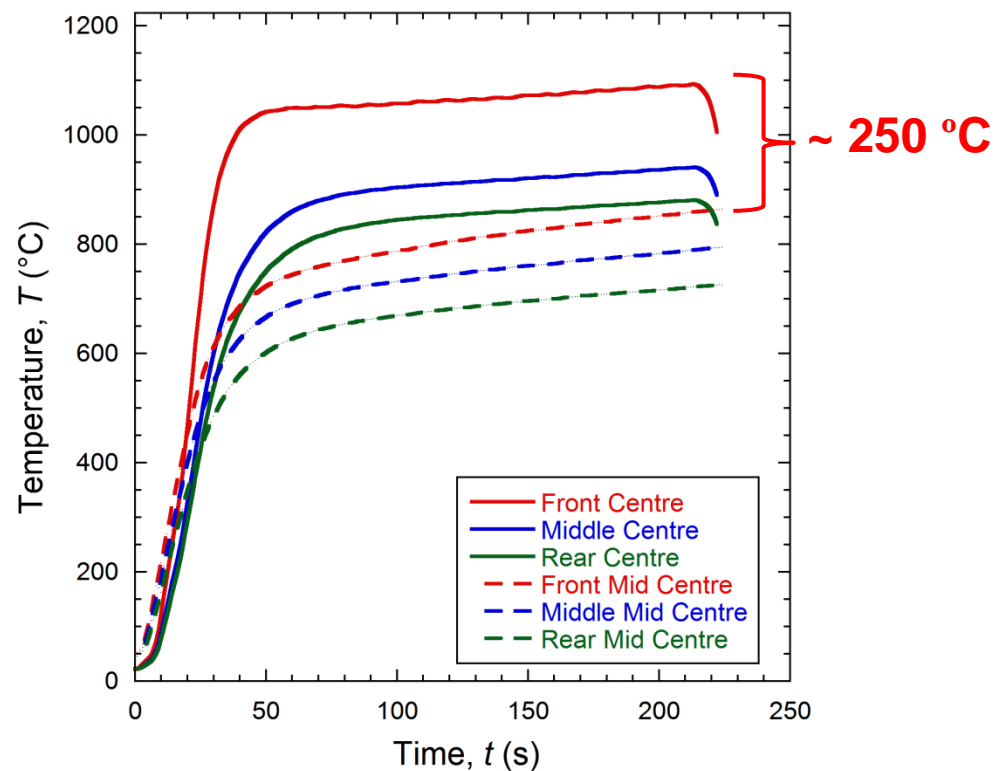


## 2. Customized Set-up

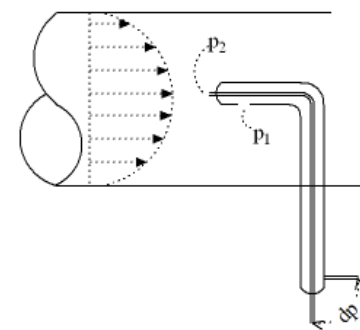
Power (kW)	Argon (L/min)	Hydrogen (L/min)	Current (A)	Pressure chamber
30	50	4	750	120 mbar



### Temperature profile



### Velocity of the gas

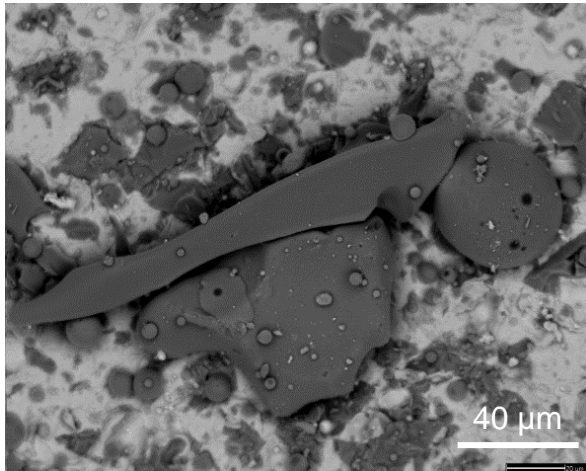


$V \sim 115$  m/s

### 3. Deposition of volcanic ash using the customized Set-up

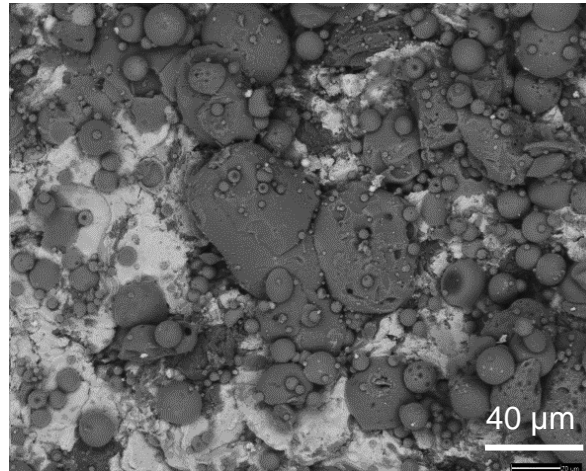
## SEM analysis of the deposited Laki volcanic ash

90  $\mu\text{m}$



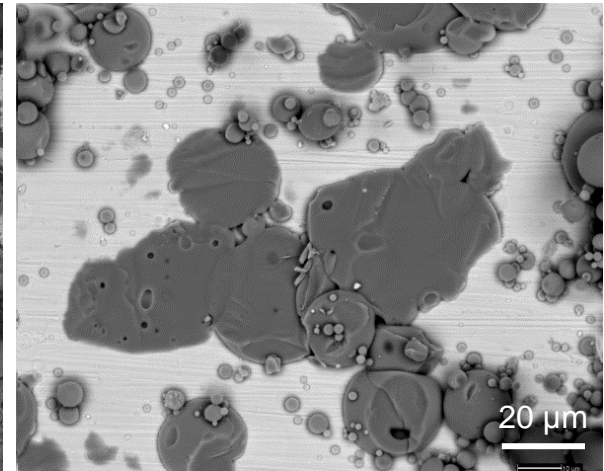
Unmelted

60  $\mu\text{m}$



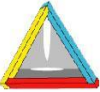
Softened/Deformed

25  $\mu\text{m}$



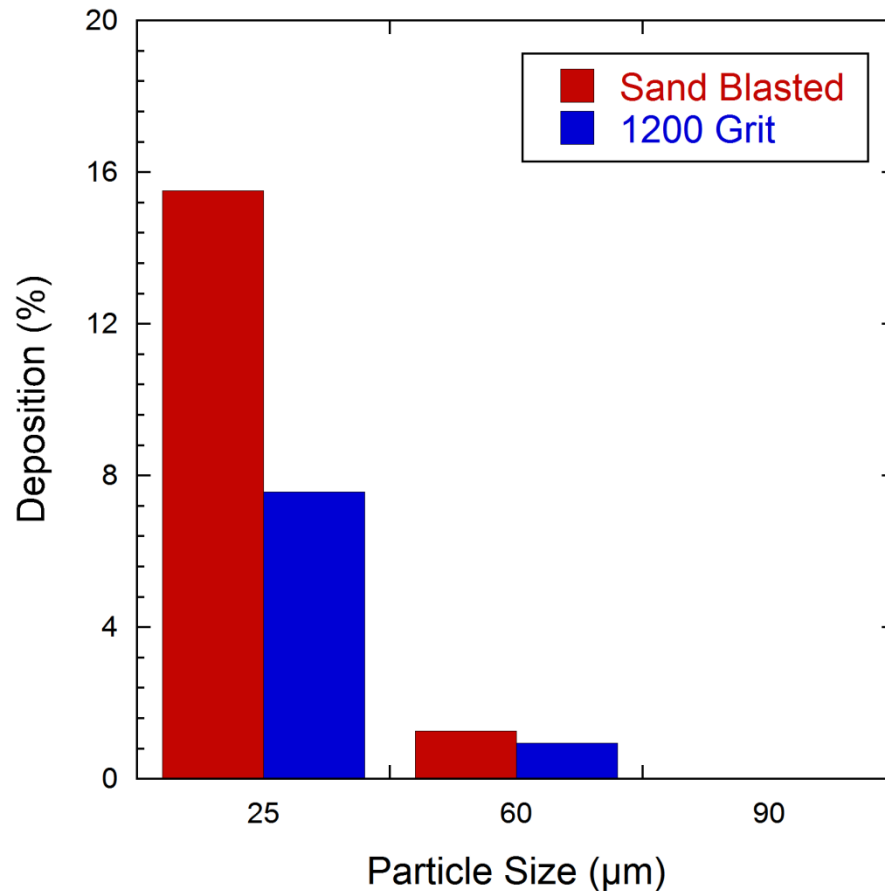
Melted/Splat





### 3. Deposition of volcanic ash using the customized Set-up

#### Deposition Efficiency



#### ✓ Particle size:

Small particles tend to present higher deposition

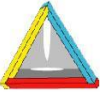
$25\ \mu\text{m} > 60\ \mu\text{m} > 90\ \mu\text{m}$

#### ✓ Surface roughness:

An increase on the surface roughness (sand-blasting) increases the deposition rate.

Sand-blasted  $25\ \mu\text{m} >$  Ground  $25\ \mu\text{m}$

Sand-blasted  $60\ \mu\text{m} >$  Ground  $60\ \mu\text{m}$



## 4. Summary

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- Various Volcanic Ashes have been examined, and 4 chosen for detailed study: these have  $T_g$  values around 600-700°C and glassy contents ranging from 25% to 85%. Crystalline melting temperatures are around 1000-1100°C.
- A novel (dilatometric) procedure has been developed for evaluation of  $T_g$  (softening temperature).
- Preliminary trials have been carried out (using Laki ash, 70% glassy) with a novel Combustion Chamber Simulation Rig (based on a Plasma Torch).
- It's been shown that extensive particle deposition can occur, even with the temperatures in the Rig no higher than about 1000°C.
- Higher deposition rates appear to occur with finer ( $\sim 25\ \mu\text{m}$ ) particles, whereas during earlier trials in a small jet engine they were higher with medium particle sizes ( $50\ \mu\text{m}$ ): detailed modelling of the gas flow in the two cases should assist in exploring this.
- Deposition rates are higher on rougher surfaces.



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**Thank you very much for your attention**