A comparative Investigation of the Physio-mechanical Characteristics of Amorphous and Crystalline Silica (RHA) Compacts

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SiO_2 CERAMIC REINFORCEMENT

- Fume silica
- Quartz
- Nano silica
- Sol-gel silica
- Rice husk silica

CERAMIC REINFORCEMENT

RHA

- RHA is a great environment threat causing damage to the land and the surrounding area in which it is dumped
- Benefits of using the RHA as a reinforcement are the production of low-cost byproducts, reduced prices for composite products, cheaper price and availability, and lighter than conventional ceramics reinforcements
- RHA have low density and contain hard ceramic particles like silica etc., making them suitable for the development of light weight, high strength AMCs
- RHA contains **SiO_2**(94%),K_2O(2.49%),Cao(.622%),Mgo(.44%),Al_2o_3(.24%),Fe_2o_{23}(.13%), N_2O

•Low cost
•Easy processing
•Waste recovery

Application

- The potential application of silica is not limited to structural refractories, but also, they are widely used by semiconductor and insulator industries and as an excellent adsorbent
- Intermetal dielectric
- Isolation
- Capacitors
- In Pharmaceutical-maintain the strength and density of bones
- Apart from dense silica, porous silica has been widely used in various applications

Properties

- Thermal stability
- Chemical and magnetic field inertness
- Excellent biocompatibility
- Density 2.64 gm/cm3
- Bulk modulus 33.5 GPa
- Melting point 1713°C

Pretreatment of RHA

- The Rice Husk is thoroughly washed with water to remove dust and dried at room temperature for 1 day.
- Heated to 200˚C for 1h to remove moisture and volatile materials.
- Heated to 600˚C for 5h to remove carbonaceous material.
- It was observed that colour of ash changes from black to grayish white.
- The change in colour is due to removal of carbonaceous material.
- The end product is Silica rich RHA.

Result and discussion

- ❖Rice husk from agricultural waste is successfully collected.
- ❖Thermal treatment has been done for certain temperatures.


@100ºC


@200ºC


@300ºC


@400ºC


@500ºC


@600ºC


@700ºC


@800ºC


@900ºC


@1300ºC

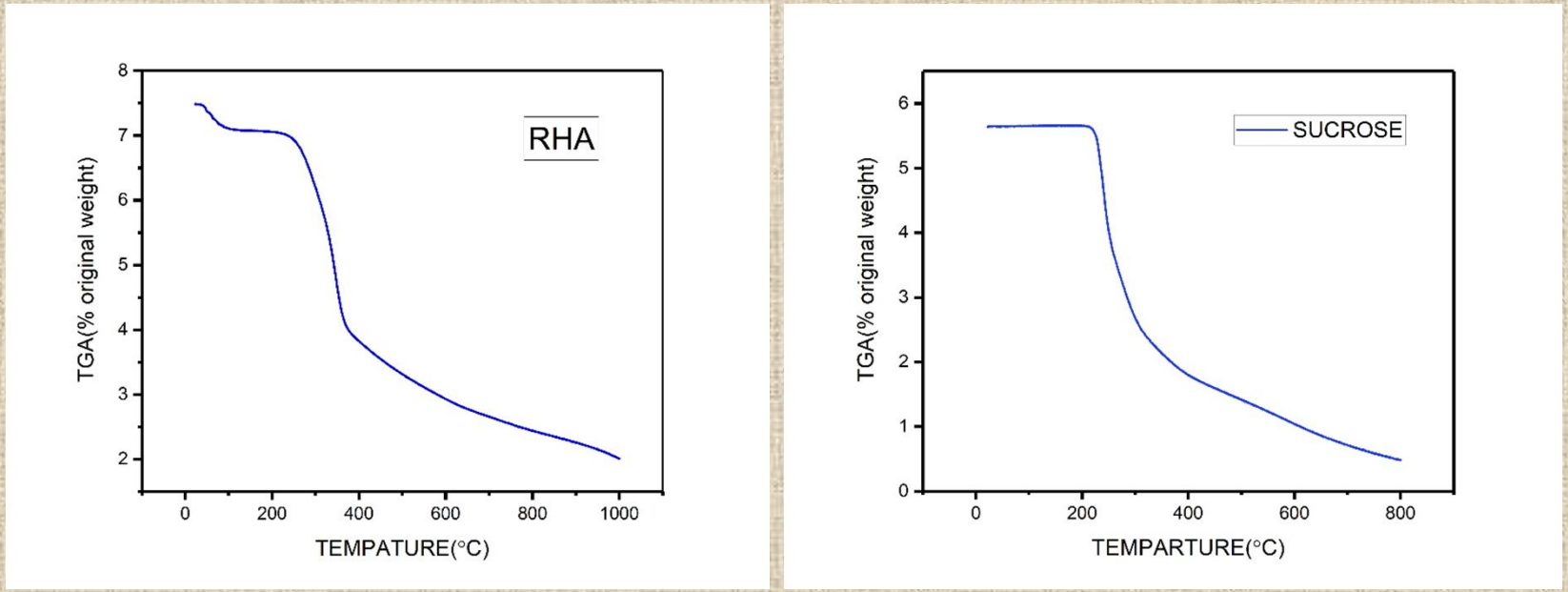
✓There is no effect on the RH when it is heated at 100ºC

✓When the temperature reaches 200ºC it starts to burn and at 300ºC it completely turns to black because of the hydrocarbon content in the rice husk.

✓The RH colour changes into white (400ºC) and turns into completely white beyond 800ºC.

✓After 800ºC t it started sticking with the alumina crucible and making lumps upto 1300 ºC.

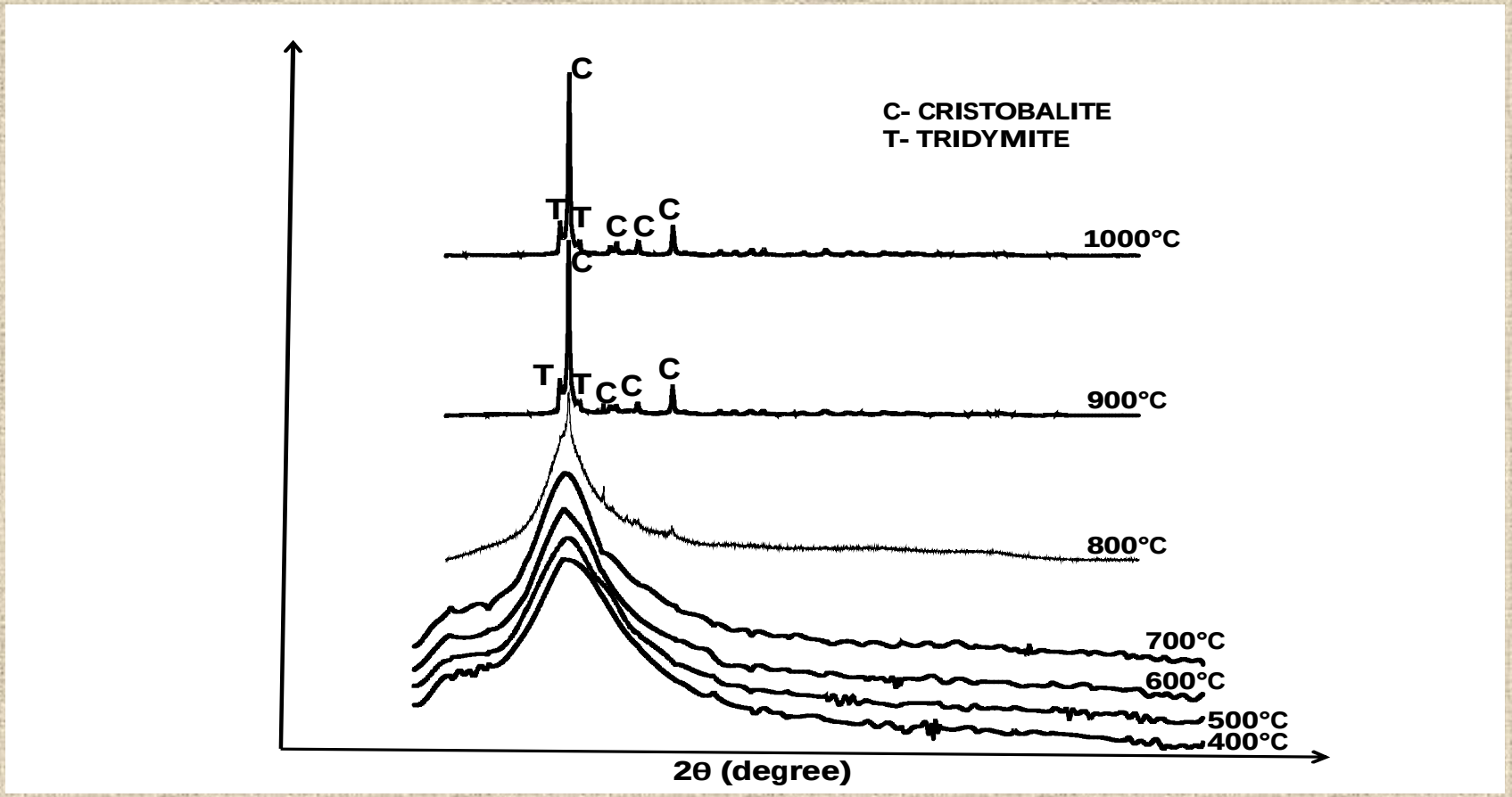
TG-DTA ANALYSIS



TG analysis of a) RH powder and b) sucrose in air

- Decomposition of both RH and sucrose is gradual from approximately 200◦C and continues up to a temperature of 450–500ºC.
- Weight loss takes place between 200ºC and 500ºC

XRD ANALYSIS



✓Silica in the rice husk initially exists in the amorphous form, but above 800°C it showed crystalline form of silica.

✓Two crystalline form of silica in RHA ceramics is cristobalite and tridymite.

✓Peak intensities become more pronounced after increasing heating temperature.

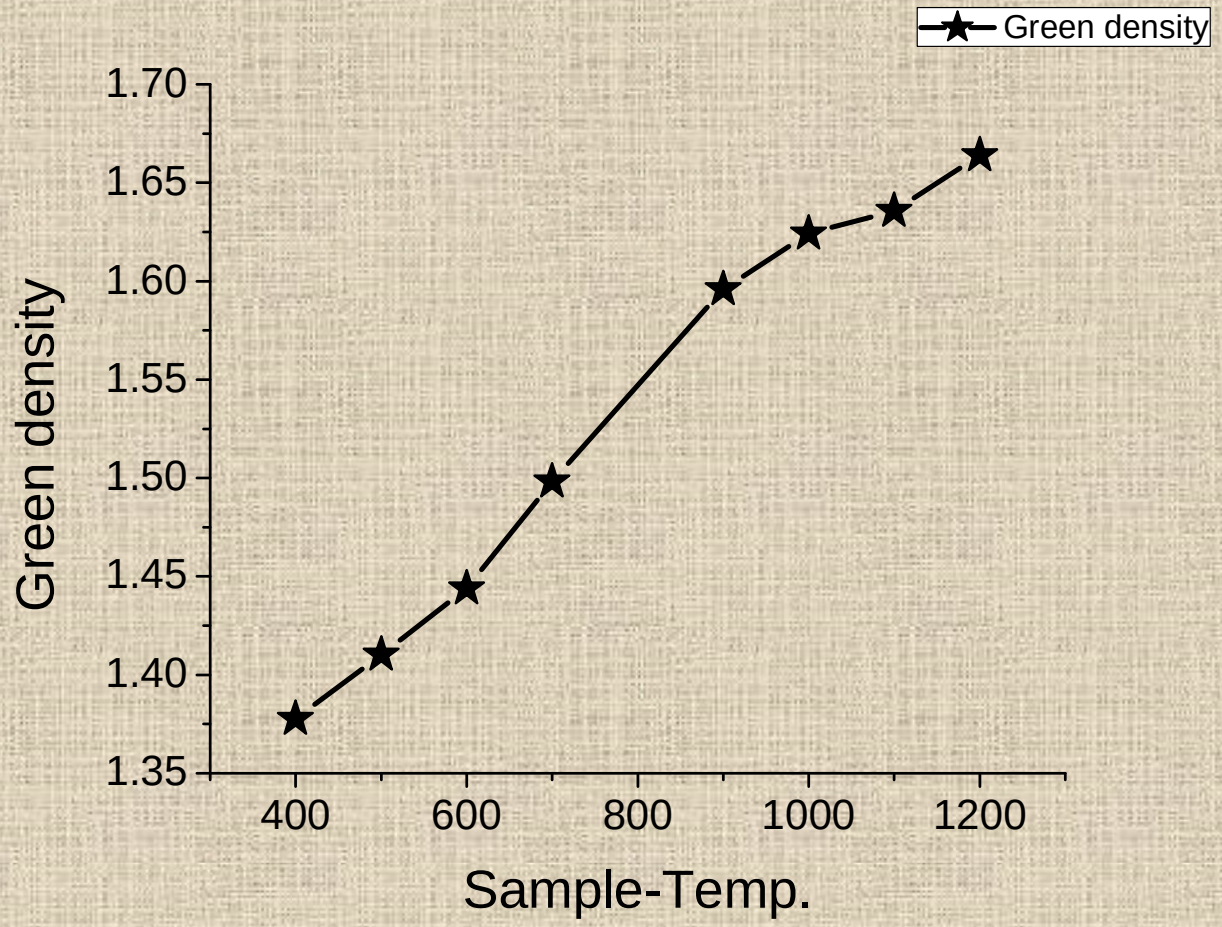
Sample Preparation

- Sample preparation process took place by mixing the amorphous and crystalline RHA with the binder by using compaction process.
- RHA Pallet sintered at 1450 °C,1500 °C and 1550°C amorphous silica at 700°C and crystalline silica 900°C

Characterization and Mechanical Analysis

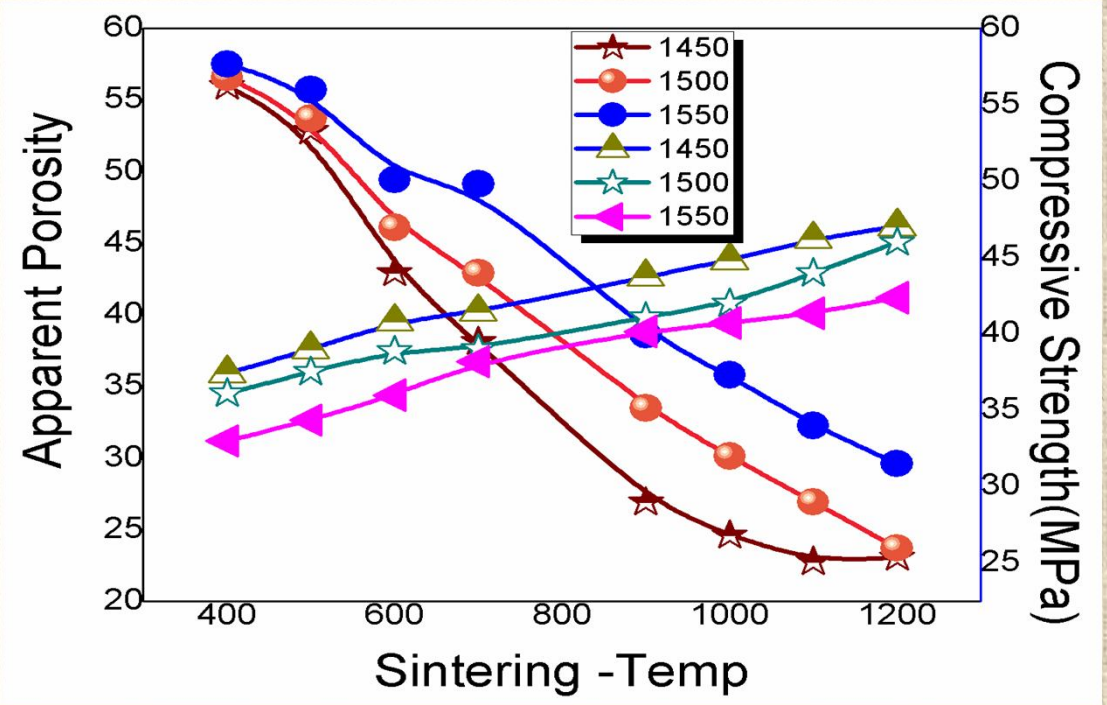
- Analysis of Green density .
- Analysis of apparent porosity.
- Analyzing compressive strength
- And morphology study through SEM
- Phase study through XRD

Green density



✓Samples prepared using amorphous form of RHA shows lesser green density as compared to samples prepared using crystalline silica.

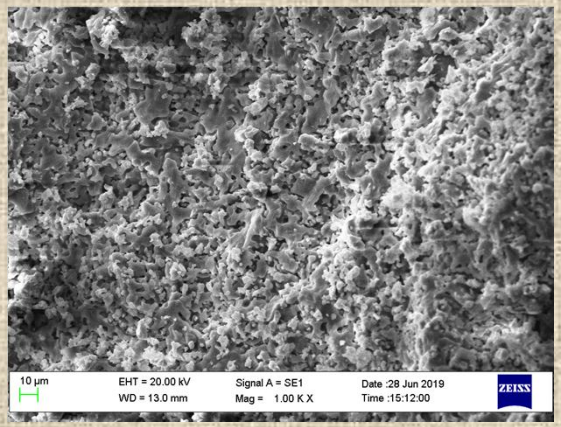
Apparent porosity V/S Compressive Strength



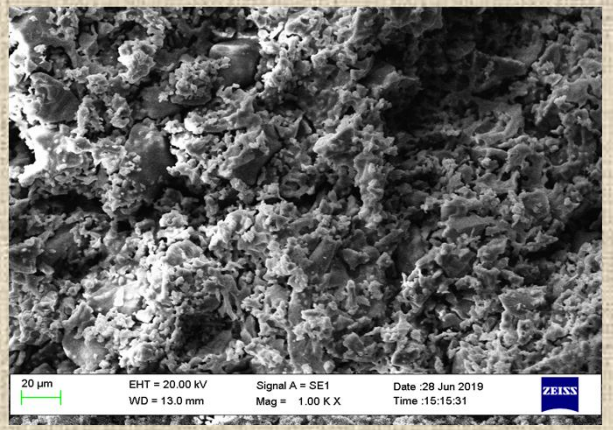
✓Samples prepared with using amorphous RHA showed greater compressive strength and lower apparent porosity compared to samples prepared using crystalline RHA.

✓Trend is opposite to the trend obtained in green density and is attributed to better diffusion and densification of amorphous form than crystalline form while sintering process

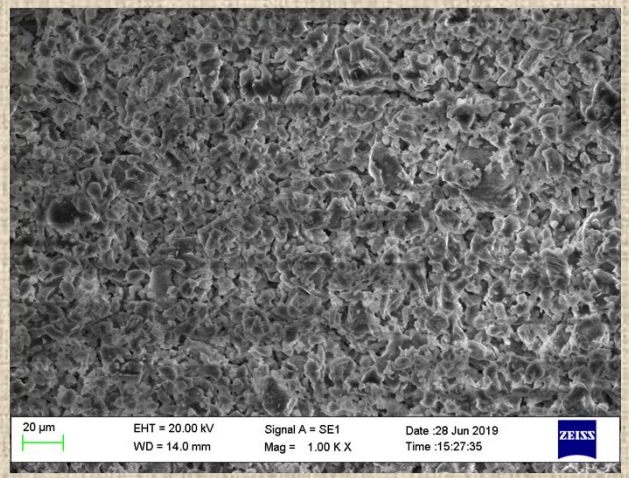
Morphology through SEM



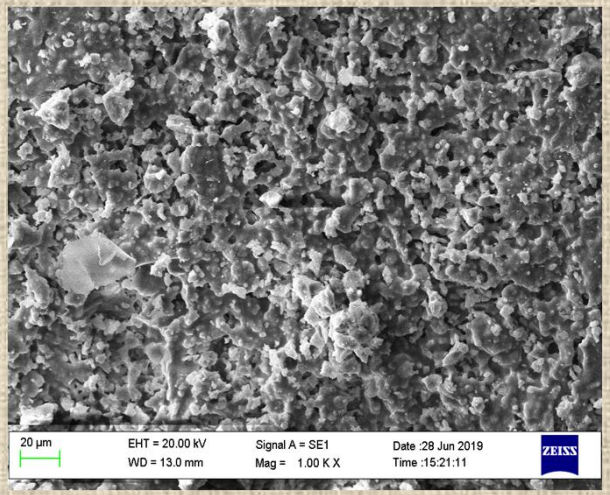
Amorphous silica 700 °C sintered at 1450°C



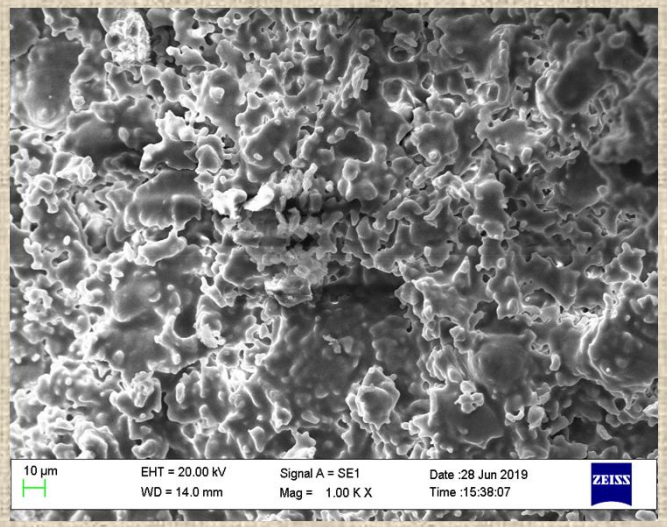
Crystalline silica 900°C sintered at 1450°C



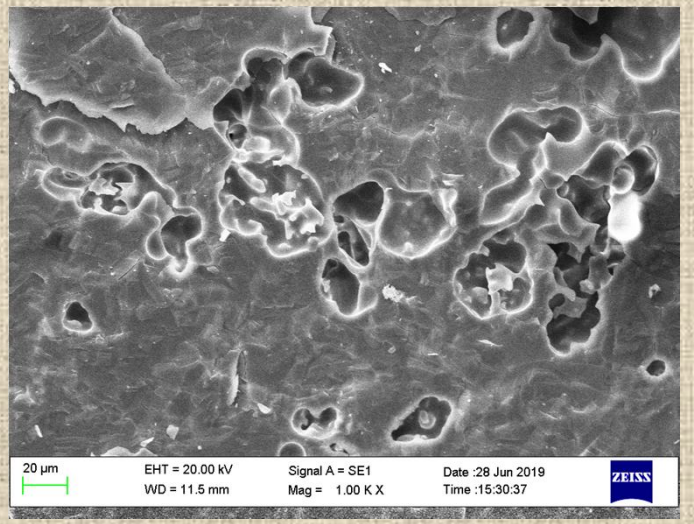
Amorphous silica 700 °C sintered at 1550*C



Crystalline silica 900 °Csintered at 1550°C



Amorphous silica 700 °C sintered at 1600°C



Crystaline silica 900 °C sintered at 1600°C

✓It was seen that the Amorphous silica have less pore at 1450 °C rather than 1600°C

✓SEM indicate that sintered at 1600°C glassy phase was obtained For both Amorphous silica and Crystaline silica.

Conclusion

- RHA silica is in the amorphous form up to 800 ◦C, which ultimately converts to crystalline after 900 ◦C.
- Cristobalite phase is the main dominant phase at higher temperatures with some traces of tridymite(depend on impurities cao in sio2).
- Tridymite to cristobalite inversion occurs at 1470 ◦C
- Bulk density and compressive strength in the range of 1.59 g/cm3-1.97 g/cm3 and 20 MPa–52 MPa
- Concluded that amorphous RHA obtained at lower temperatures are better used to make silica compact for better strength. Still, if porosity is the concern, crystalline RHA of higher temperatures will be the preferred one

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THANK YOU