Advanced processing of high-purity amorphous silica fine particles originated from rice husks

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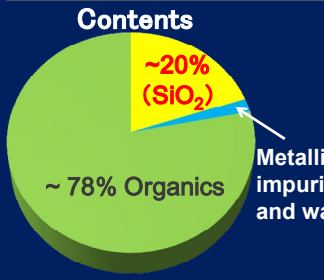
Objective

Rice husks and straw, containing ~78 mass% organics and ~20 mass% amorphous silica, are representative non-eatable biomasses. To attain high-purity silica from the remains of the rice husks after air combustion, the optimization of the process conditions of the citric acid leaching treatment and water rinsing process of rice husks were conducted to remove the metallic impurities from husks and promote the hydrolysis reaction of polysaccharides. When the citric acid solution with a concentration of 1 mass% or more was used, alkali metal oxides of Na_2O and K_2O were completely removed. Carbon content of ashes was drastically reduced to 0.02–0.04 mass% after combustion, and high-purity amorphous silica with 99.5–99.77 mass% were produced from rice husks.

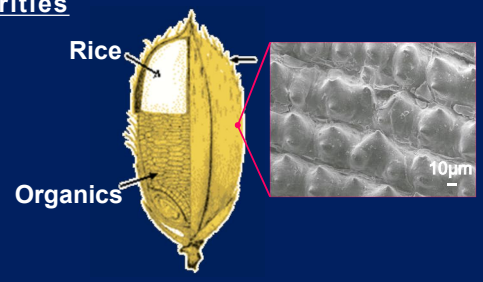
Experimental procedure



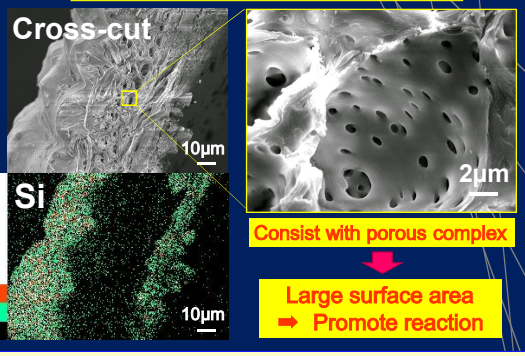
Metallic impurities

K	~0.5
Na	~0.03
Mg	~0.05
Ca	~0.16
Al	~0.04
Fe	~0.02

(in mass%)

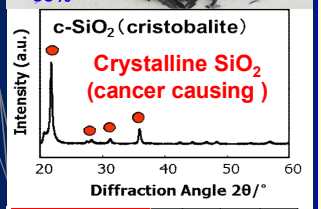


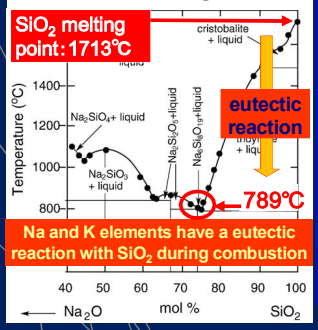
Characteristic of rice husk



Consist with porous complex

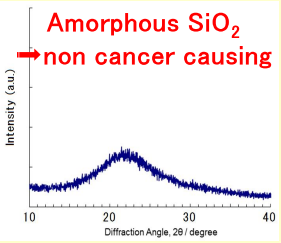
Large surface area ➡ Promote reaction



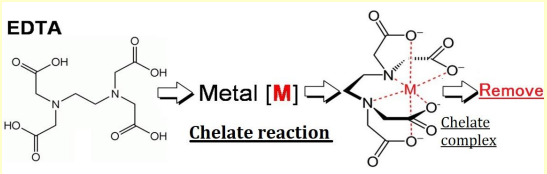


Na and K elements have a eutectic reaction with SiO_2 during combustion

Na and K were completely removed during citric acid leaching, therefore, it is obtained high purity and amorphous silica.



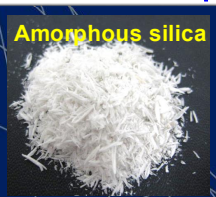
Chelate reaction mechanism



Patents: JP 5100385, JP 5213120
Trademark: バイオシリカ®

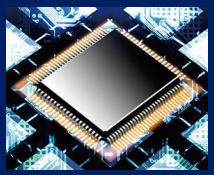
- **Chelate reaction** between –COOH groups and metallic impurities.
  ➡ Chelate complexes are formed and discharged from the husks into the acid solution.
- **Hydrolysis reaction** of cellulose and hemi-cellulose of rice husks from polysaccharides to monosaccharides by the citric acid solution.
  ➡ –COOH groups easily pass through monosaccharides.
  ➡ Easily contact with metallic impurities contained in rice husks.

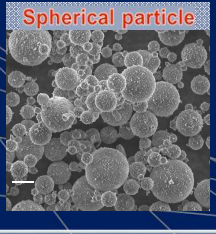
Application of Amorphous Silica Materials



① Fertilizer

② Semi-conductor





③ Reinforcements for concrete materials