Effects of Pumice Powder on Silicone Exterior Coating Material

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Abstract. Pumice has been used mainly in structural applications such as light-weight concretes, cements, and filters. Despite being used mostly in these areas of construction industry, pumice has very few applications in other sectors. Especially in the present investigation, it has been aimed to spread the usage of pumice in different sectors by analysing the particle size of the material. In cooperation with the factory and the processes of production of building chemicals was observed and it was investigated the characterization of the material produced by using FE-SEM. So that the microstructure images and Energy Dispersive X-ray Spectroscopy (EDS) composition analyses were obtained. It was observed that there has been a negligible amount of reaction between the Silicon and the pumice particles. In similar studies, when the doping is carried out at high temperatures, unwanted reactions (insulation, mechanical strength, etc.) occur between the particle and the base material and this affects the physical properties of the material in a negative way. In this study, due to the doping is in room conditions, there is little reaction between the particle and Silicon.

1. Introduction
Pumice is a silica-base porous aggregate which forms naturally during volcanic eruption [1,6,7]. The pressure drops due to the rapid expulsion of magma into the atmosphere causes there leave of dissolved gases which forms magma froth. The falling magma froth turns to a porous ceramic after solidification [2]. Pumice is mainly surface-mined in large quantities and has been used in structural applications such as light-weight concretes [3], cements [4,8], and filters [5]. Despite being used mostly its applications of construction industry, pumice has very few applications in other sectors. Especially in the present investigation, it has been aimed to spread the usage of pumice in different sectors by analysing the particle size of the material.

2. Material and Methods
2.1. Fabrication process
Pumice is extracted in surface mining and hence comes with some impurities [1]. The as-received pumice powder, provided by Novelart Construction Chemicals & Exterior Insulation Accessories Company, was put on precision weighing before starting sieve analysis. The mixture as-weighed 342 g and scaled 3 mm was micronized using the sieve shown in Figure 1. Then the micronized pumice particles are doped to the pre-prepared Silicon in the specified amount to distribute the pumice particles in a homogeneous manner with the help of the mixer rotating at a specific time interval and for a certain period. The hydraulic mixer shown in Figure 1 was used to enable the doping to take place...
homogeneously. The mixing period of the mixer was set to 1600 rev/min before the doping was made (1600 revolution in 1 minute). These samples are naturally solidified under atmospheric conditions without any heat treatment. The absence of extra processing for maximum wetting between pumice particles and Silicone makes this study exceptional.

![Figure 1. The devices used in the preparation of the micronized pumice powder](image)

(a) Density container (b) Precision weighing (c) Hydraulic mixer (d) Sieve in different scales

### 2.2. Characterisation of samples

Pumice is a porous glassy volcanic rock, which is formed by cavities, spongy, volcanic events and resistant to physical and chemical factors [7]. During its formation, it contains numerous porous ranging from macro scale to micro scale due to sudden cooling and sudden abrasion of the gases in the structure. As the porous are generally (especially microporous) unconnected hollow, heat and sound insulation is very high.

As a result of volcanic events, pumice is two types; acidic and basic. The most common is acidic pumice. Acidic pumice is white & dirty white color. According to the Mohs Scale; its hardness 5 ~ 6 and its density 0.5 ~ 1 gr / cm³. Basic pumice is brown & black and heavier. According to the Mohs Scale; its hardness 5 ~ 6 and its density 1 ~ 2 gr/cm³[9].

500 microns mixed pumice; black and white pumice is shown in Figure 2. And also, the smallest pumice particles obtained in the experiments are seen as 90 microns.

![Figure 2. Obtained micronized pumice powder samples; 0.5 mm and 0.09 mm](image)
3. Results and Analysis

3.1. Chemical composition of pumice

The pumice powder was micronized at 90, 250, 500, 700 microns scales by sieve analysis. The pumice density was obtained about 0.5-1 g / cm$^3$. Microstructure images have been analyzed by Scanning Electron Microscopy (SEM), and composition analysis by Energy Dispersive X-ray Spectroscopy (EDS). In the measurements, Cukurova University Central Research Laboratory, FEI Quanta 650 model Field Emission Scanning Electron Microscope (FE-SEM) and BSD detector have been used.

In the SEM analyzes carried out on the samples, it has been observed that there has been a negligible amount of reaction between the Silicon and the pumice particles. In Figure 3, SEM images of 700 microns black pumice powder and 700 microns white pumice powder have been given. In figure 4, EDS results of these pumice powders have been seen. So that the element content of the sample have been determined. It is clear that, as the Silicon ratio increases, the pumice stone's colour is close to white. Each table showing the elemental composition of pumice particles is given in the relevant micrograph. In Figure 5, we see EDS results of silicone exterior coating material when pumice doped or not doped. Due to the porous and spongy structure of the pumice, it shows the maximum wettability between pumice particles and silicon. The wetness of the new material between the particle and the silicone is proved to be good. The advantage of this is that the external cracks that may occur in buildings are eliminated due to the flexibility of pumice doped silicone. This is an advantageous situation in new buildings. In Figure 6 and Figure 7, EDS results of silicone exterior coating material when pumice doped or not doped have been given. When we look silicone rates, we see, while the silicon is heavy in pure form, the new material obtained with pumice doped silicon is lighter. This is due to the porous structure in the pumice.

3.2. Physical properties of pumice

Generally, the physical properties of pumice are caused by ceramic based elements in the composition. The SiO$_2$ content of the pumice gives the stone an abrasion characteristic. Al$_2$O$_3$ compound, which is also found in the content of pumice, gives a high resistance to fire and heat. The high amount of porous in the pumice gives very low proportions of specific gravity and high insulating properties.

![Figure 3. SEM images of 700 microns black pumice powder and 700 microns white pumice powder](image_url)
Figure 4. EDS results of 700 microns black pumice powder and 700 microns white pumice powder

Figure 5. SEM images of silicone exterior coating material when pumice doped or not doped.

4. Conclusions
Doping was made in laboratory environment at room temperature. Making the doped at room temperature is one of the aspects that make this study privileged because of at room temperature will minimize both energy savings and undesirable reactions.

As a result of microstructure observations in present investigate, we see that the pumice structure has numerous porous structures ranging from a large number of macro scale to micro scale. It is very light due to its porous, so it is highly preferred in works without high weight. There are further experiments are required to find the density evulations and high insulating properties of pumice doped silicone exterior coating material.

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Figure 6. EDS results of silicone exterior coating material when pumice not doped.

Figure 7. EDS results of silicone exterior coating material when pumice do
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