Classification of Micrographs of Metals Images using Clustering

Methodology:

- Converted large image data into 2D array and applied PCA(Principal Component Analysis) on it
- Identified optimal number of clusters using Elbow plot for K-Means Clustering and classified images into clusters

Observations:

- Optimal number of clusters comes out as 4 and classification of images in database was done in 4 groups

Data:https://drive.google.com/drive/folders/1VwRA6Q69_9YZC2sgUR-mc9nEZnwZeAik?usp=sharing

GitHub:https://github.com/ashutoshpathak1996/Classification_of_Micrographs_of_Metals_Images_using_Clustering.git

K-Means clustering on Image Database

Importing Important Libraries

In [15]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import random
from sklearn.cluster import KMeans
from sklearn.preprocessing import StandardScaler
from sklearn.decomposition import PCA
import os
```

Accessing image database from Google Drive

In [16]:
```
path = "/content/drive/MyDrive/ME793/micrographs"
files = [f for f in os.listdir(path)]
```

Resizing of images for ease of computation using Python Image Library and creating data array for compressed images

In [17]:
```
from PIL import Image

data = np.zeros((len(files), 62500))
for i, file in enumerate(files):
    # Resizing the images to (250,250)
    image = Image.open(os.path.join(path, file)).resize((250,250))
    image_array = np.array(image).flatten()
    data[i] = image_array
data.shape
```

Out[17]:
```
(971, 62500)
```

PCA Analysis

In [18]:
```
Clus_dataSet = StandardScaler().fit_transform(data)
```

In [19]:
```
variance = 0.98
pca = PCA(variance)
```

Fiting data into our PCA instance

In [20]:
```
pca.fit(Clus_dataSet)
```

Out[20]:
```
PCA(n_components=0.98)
```

Finding reduced dimensions

In [21]:
```
print("Number of components before PCA  = " + str(data.shape[1]))
print("Number of components after PCA 0.98 = " + str(pca.n_components_))
```

```
Number of components before PCA  = 62500
```

```
Number of components after PCA 0.98 = 804
```

Transforming our data according to PCA instance

In [22]:
```
Clus_dataSet = pca.transform(Clus_dataSet)
```

In [23]:
```
print("Dimension of our data after PCA  = " + str(Clus_dataSet.shape))
```

```
Dimension of our data after PCA  = (971, 804)
```

Creating K means clustering model for k values ranging from 1 to 12

In [24]:
```
SSE2 = []
mapping1 = {}
K1 = range(1, 20)
for k1 in K1:
    # Building and fitting the model
    kmeanModel1 = KMeans(n_clusters=k1)
    kmeanModel1.fit(Clus_dataSet)
    SSE2.append(kmeanModel1.inertia_)
    mapping1[k1] = kmeanModel1.inertia_
```

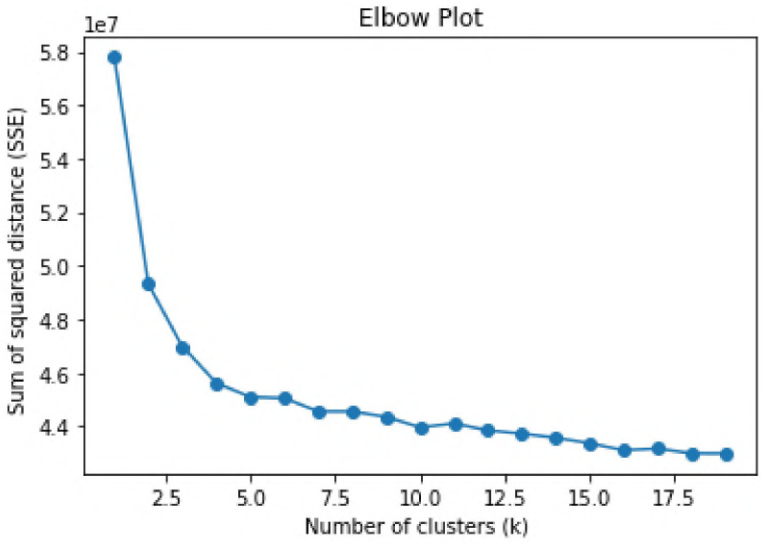
Printing k values as a dictionary

In [25]:
```
print('Sum of squared distance for corresponding k values :')
for key, val in mapping1.items():
    print(f'{key} : {val}')
```

```
Sum of squared distance for corresponding k values :
1 : 57799890.01406452
2 : 49323062.18494442
3 : 46985582.24009617
4 : 45621909.692433104
5 : 45099736.11782737
6 : 45055824.10297862
7 : 44561871.63965863
8 : 44558292.282586485
9 : 44360862.095910266
10 : 43961729.85941517
11 : 44110445.35788962
12 : 43850906.02324322
13 : 43729228.61706281
14 : 43576697.038637295
15 : 43367779.39447287
16 : 43109907.767413676
17 : 43171389.75624439
18 : 42991914.38417765
19 : 42986216.59038122
```

Elbow Plot for Image Database

In [26]:
```
plt.plot(K1, SSE2, '-o')
plt.xlabel('Number of clusters (k) ')
plt.ylabel('Sum of squared distance (SSE) ')
plt.title('Elbow Plot')
plt.show()
```



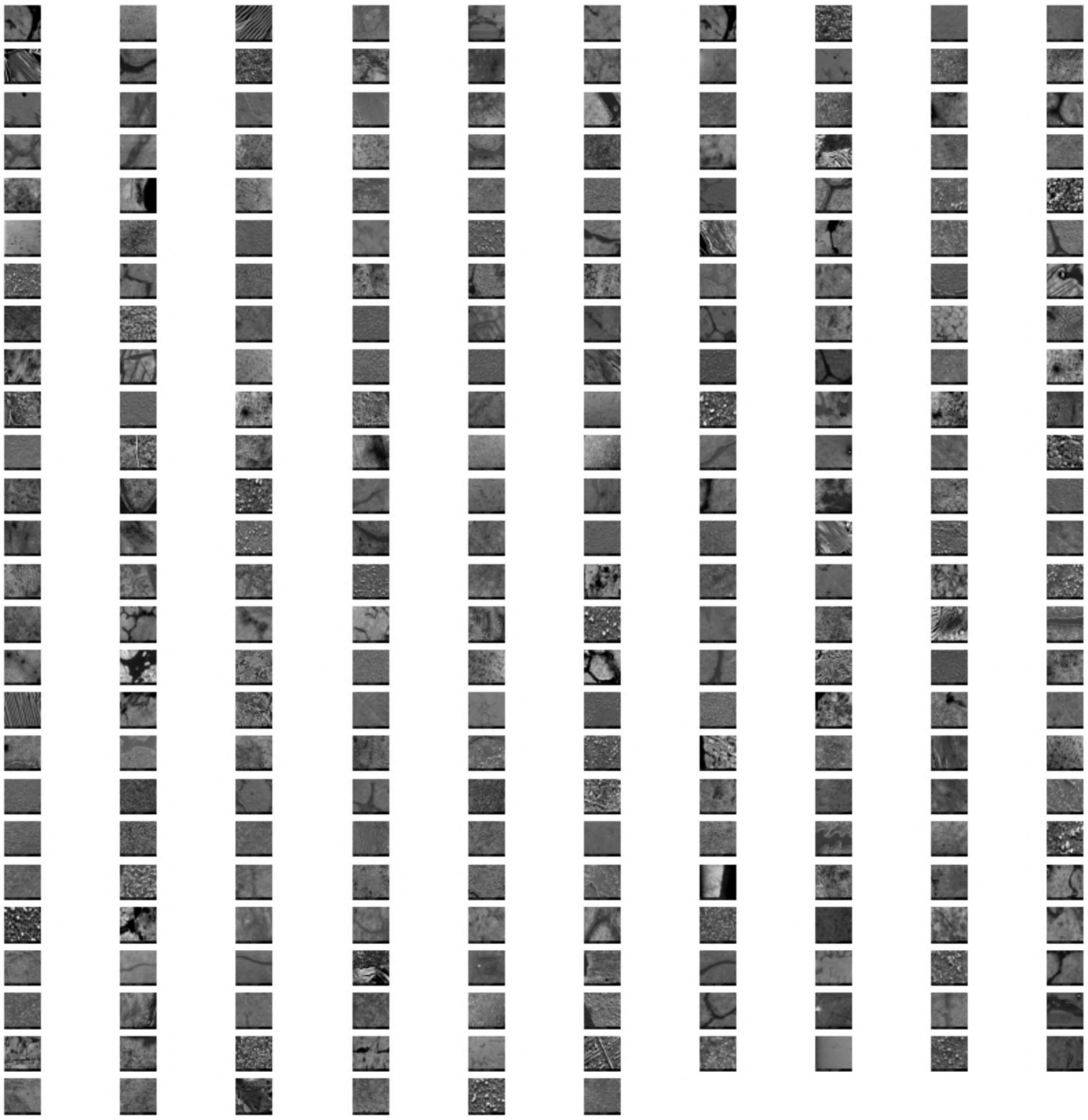
From elbow plot we realized that k=4 is optimum for classification and so we develop k means clustering model for k=4 and plot our clusters

In [27]:
```
kmeans = KMeans(n_clusters=4)
kmeans.fit(Clus_dataSet)
pred = kmeans.predict(Clus_dataSet)
```

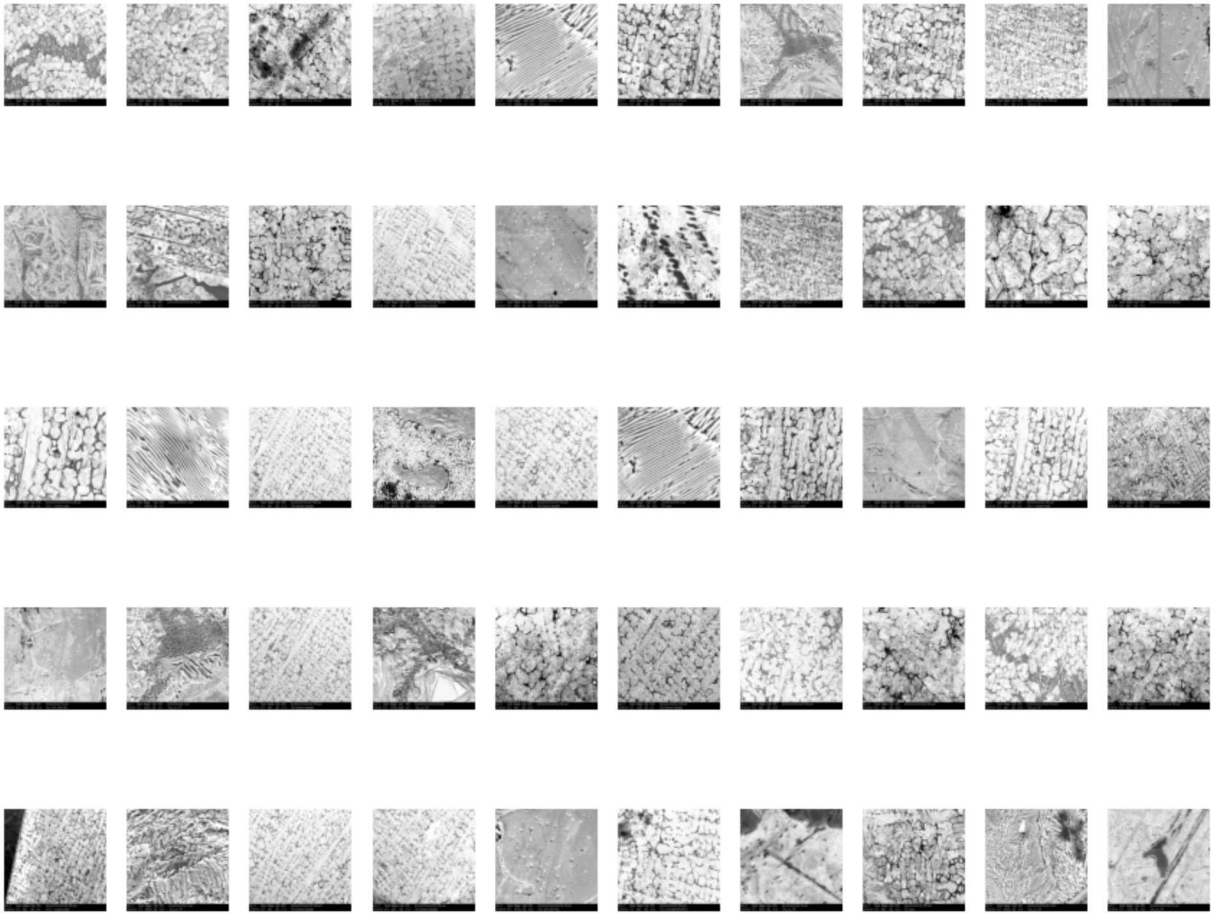
Classification of Images based on clusters plot for Image Database

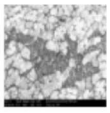
In [29]:
```
for i in range(0,4):
    row = np.where(pred==i)[0]  # row in data for elements of cluster i
    num = row.shape[0]       #  number of elements for each cluster
    r = np.floor(num/10.)    # number of rows in the figure of the cluster
    print("cluster "+str(i+1))
    print(str(num)+" Images")
    plt.figure(figsize=(15,15))
    for k in range(0, num):
        plt.subplot(r+1, 10, k+1)
        image = data[row[k]]
        image = image.reshape(250, 250)
        plt.imshow(image, cmap='gray')
        plt.axis('off')
    plt.show()
```

```
cluster 1
256 Images
```

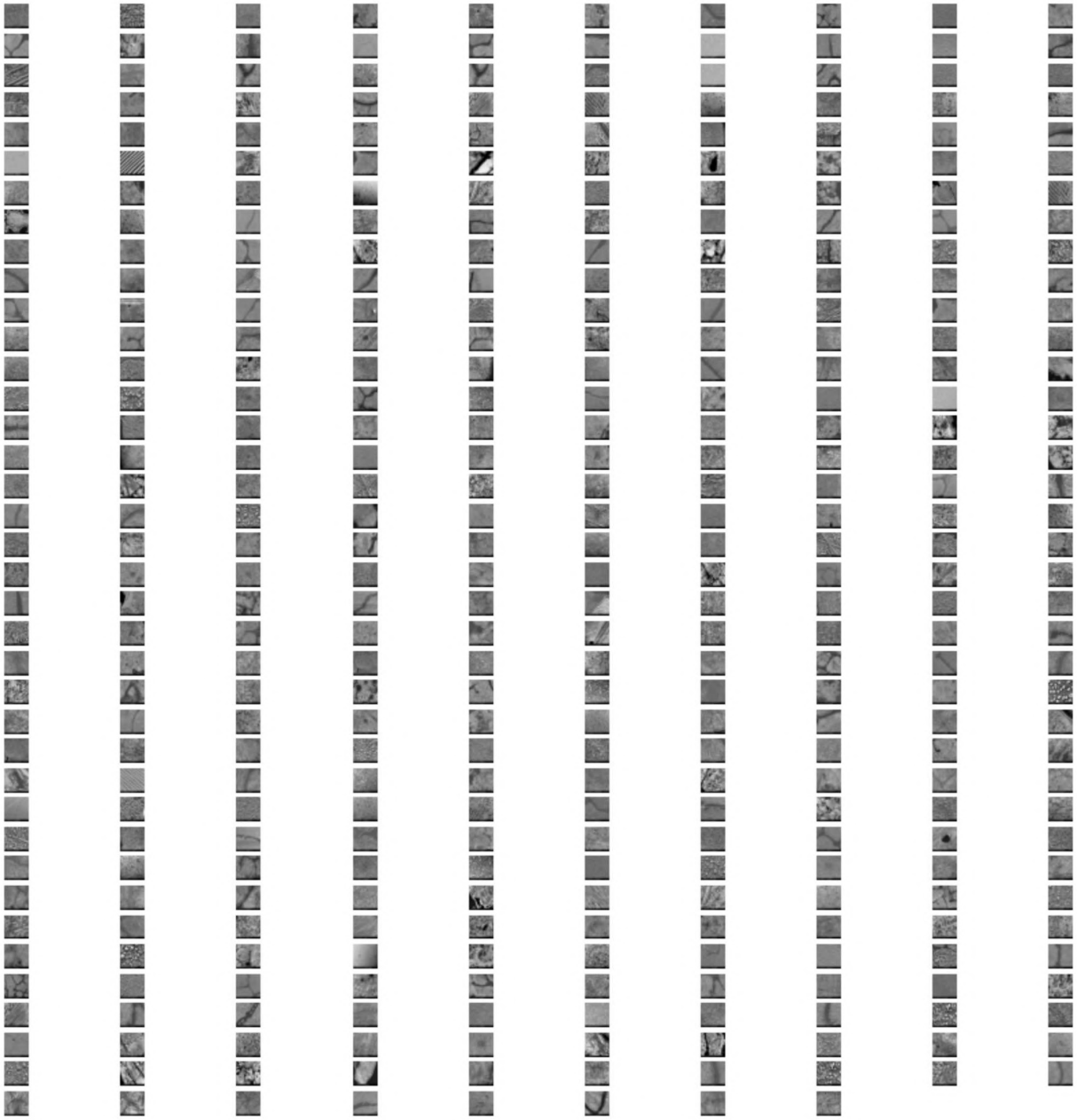


cluster 2
51 Images





cluster 3
378 Images



cluster 4
286 Images