

# THE **FUN**DAMENTALS OF CERAMICS SCIENCE

## WHAT IS A CERAMIC?

A ceramic is not a metal, nor a plastic (organic). They are what you would call a “a non-metallic inorganic solid”. They are made of metallic elements mixed with non-metallic elements. For example: Aluminum oxide ( $Al_2O_3$ ), which contains aluminum (Al) and oxygen (O), or titanium carbide (TiC), which contains titanium (Ti) and carbon (C) or even silicon nitride ( $Si_3N_4$ ) which contains silicon (Si) and nitrogen (N). The list goes on and on...

### TRADITIONAL CERAMICS...

Are made of three basic ingredients: clay, quartz, and minerals. All these are found in nature and are used in different proportions according to their application to make things like bricks, pottery, and china.



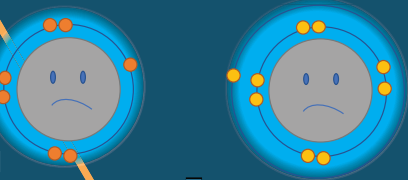
### ENGINEERING CERAMICS...

Are used for high-tech applications and are generally man-made as they need to be extremely pure. As a result, they offer properties not achievable with traditional ceramics.

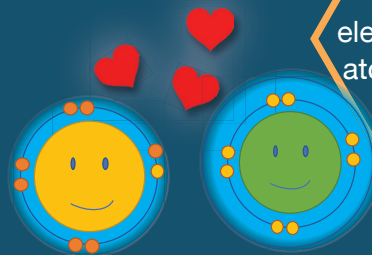


## WHAT MAKES CERAMICS DIFFERENT FROM METALS? HOW THE ATOMS ARE BONDED TOGETHER!

Ceramics are made of **covalent** bonds between metal and non-metal atoms. This means that atoms share electrons between each other forming a **strong bond**.



Ceramics can also have **ionic** bonds, where one atom donates spare electrons to the neighboring atom to form a bond with it. These are weaker than covalent bonds.



## NOW THAT YOU'VE BONDED THE ATOMS TOGETHER, THINK ABOUT HOW THEY CAN BE ARRANGED...

**Non-crystalline Ceramics:** Now think of people milling in a mall. Atoms in a non-crystalline ceramic are just like that—arranged randomly. Did you know that glass is a ceramic? A glass is a type of non-crystalline ceramic, which gives it a wide range of properties.



### Crystalline Ceramics:

Crystals have atoms arranged in a specific way with regular, repeating units. Think of a military parade, where every person is in a specific place!



**HIGH**  
Stiffness, Hardness, Melting point & Corrosion resistance

**INTERMEDIATE**  
Density & Strength

**LOW**  
Flexibility

## PROPERTIES OF CERAMICS

The properties of all materials are decided by their atomic structure and bonding. Ceramics have the strongest types of bonds, making them very hard and stiff. This also makes them brittle and fragile. For example, if a ceramic mug gets chipped when dropped, it is much more likely to crack when compared to a metallic or plastic mug. So, in general, how do the properties of CERAMICS compare to metals and polymers? Read to the left!

For more information visit [ceramics.org/ceramics-are-cool](http://ceramics.org/ceramics-are-cool)

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