Industry Day Theme # Sustainable Medical Technologies

"EFFECT OF PRESSURE AND PARTICLE SIZE VARIATION ON THE MICROSTRUTURE AND COMPRESSIVE DEFORMATION BEHAVIOUR OF Ti-15Mo FOAM"

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Abstract

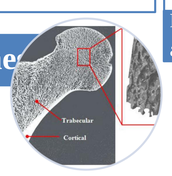
Two different particle sized Mo powder is used here. In the current work, the objective is to optimize the properties of Ti-15Mo foam. In order to achieve Favourable mechanical properties for bone repair implants, metal powders and Space holder in different proportion were mixed with organic binder and then cold compacted under compaction pressure of 100MPa, 200MPa, 300MPa. Microstructural characteristics, plateau stress, compressive deformation behaviour and modulus of elasticity of the sintered samples were examined. It was found that the elastic modulus of the high porous samples sample is in the range of 0.18GPa to 1.47GPa which is in the range of highly porous cancellous bone (0.1-0.4GPa) and the compressive strength of the samples with relative density (0.29 – 0.38) are in the range of 6.0MPa to 23.26MPa which also are in the range of cancellous bone.

It was also found that when the particle size of the Mo powder was kept 37.25 micron, it gives better result as compared to when the size of the Mo powder was kept 3 micron while keeping size of Ti same in both the cases i.e. 45.8 micron.

Introduction

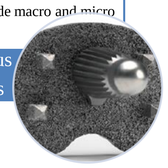
- Interconnected porous structures
- high porosity (>50%)
- Macro-pore size (150-500μm)
- Elastic modulus - 0.01 to 30 GPa
- Compressive strength -0.2 to 200 MPa

Bone



- Reduce the elastic modulus value
- Provide macro and micro pores

Porous alloys



Human joints suffer from Osteoporosis, osteoarthritis, trauma etc.

By the end of 2030
Total hip replacements - rise by 174% (572,000 procedures)
Total knee replacements –rise by 673% (3.48 million procedures)

Revision surgery due to failure of implants

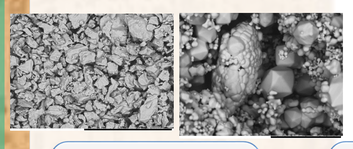
Development of appropriate materials

Suitable mechanical properties | **Good corrosion and wear resistance**

Orthopaedic implants

Excellent biocompatibility | **Osseointegration**

Materials and Methods

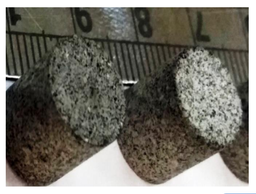


- Ti, Mo
- NH_4HCO_3 as space holder
- PVA as organic binder

Mixing

Compaction

- Uniaxial compression in cylindrical die
- 100 MPa, 200 MPa, 300 MPa



Preheating

- 150°C for 2hr
- 300°C for 3hr

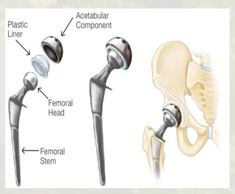
Sintering

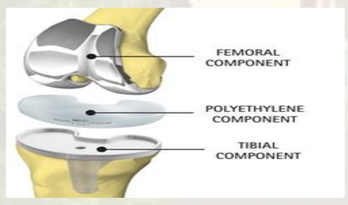
- 1200°C at a rate of 5°C/min for 2 h
- 10^{-5} Torr Vacuum pressure

Conclusions

- It was found that the elastic modulus of the high porous samples is in the range of 0.18 GPa to 1.47 GPa which is in the range of highly porous cancellous bone (0.1-0.4GPa) and
- The compressive strength of the samples with relative density (0.29 – 0.38) are in the range of 6.0 MPa to 23.26MPa which are in the range of cancellous bone.
- It was also found that when the particle size of the molybdenum powder were kept 37.25 micro gives better result as compared to when the size of the molybdenum powder kept 3 micron keep in size of Titanium powder same in both the cases i.e. 45.8 micron.

Industrial Significance





Result

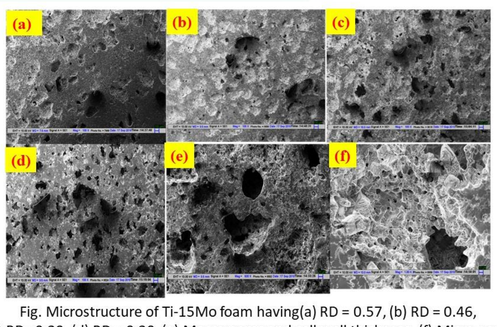
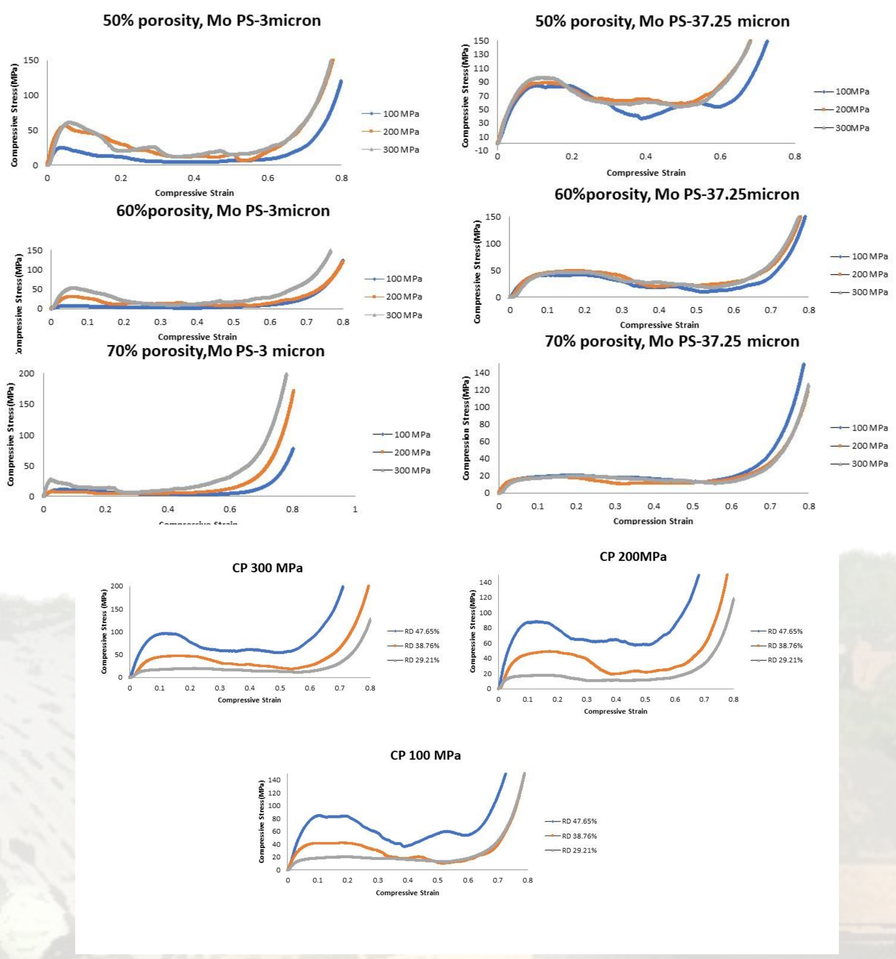


Fig. Microstructure of Ti-15Mo foam having(a) RD = 0.57, (b) RD = 0.46, (c) RD =0.39, (d) RD = 0.30, (e) Macro pores and cell wall thickness, (f) Micro pores

Porosity	Average Microhardness (kg/mm²)
50%	176.825
60%	130.50
70%	67.77



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