Title

Highly porous CP-Ti foams manufactured with powder compaction, the space holder method and plasma-assisted sintering for biomedical applications

Abstract

High porosity titanium foams are used to replace bone structures with low elastic modulus due to their ability to avoid the phenomenon of stress shielding. Producing foams with porosity levels above 70 % in volume using space holders is challenging because the component can collapse or lose shape during processing. In this study, commercially pure Ti powder was mixed with 50, 70, and 80 vol% potassium chloride (KCl) as space holder, cold-compacted, and sintered in a plasma-assisted reactor to obtain high porosity foams. Plasma-assisted technique was used to remove KCl using heat in the sintering reactor. The porous amount of the foams was measured using Archimedes principle and studied through X-ray microcomputed tomography, and the elastic modulus of the foams was measured using ultrasonic wave transmission. The present study showed that the space holder method and plasma sintering can produce CP-Ti foams with predictable porous architecture, reduced shrinkage, and increased porosity than conventional sintering. © 2024 Elsevier B.V.

Authors

Cavilha Neto F.; Salinas-Barrera V.; Aguilar C.; Dal'Maz Silva W.; Binder C.; Klein A.N.

Author full names

Cavilha Neto, Francisco (57221394849); Salinas-Barrera, Vicente (58889410100);

Aguilar, Claudio (56166871800); Dal'Maz Silva, Walter (54974137200); Binder, Cristiano (36609907100); Klein, Aloisio Nelmo (7402143631)

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Affiliations

Mechanical Engineering Department, Federal University of Santa Catarina (UFSC), Materials Laboratory (LABMat), Rua Delfino Conti, S/N, Trindade, Florianópolis, 88040-900, Brazil; Grupo de Investigación en Física Aplicada, Instituto de Ciencias Aplicadas, Facultad de Ingeniería, Universidad Autónoma de Chile, Av. Pedro de Valdivia 641, Providencia, Santiago, Chile; Departamento de Ingeniería Metalúrgica y de Materiales, Universidad Técnica Federico Santa María, Av. España 1680, Valparaíso, 2340000, Chile; Institut Jean Lamour – UMR CNRS-Université de Lorraine, 7198, Parc de Saurupt, Nancy, 54011, France

Authors with affiliations

Cavilha Neto F., Mechanical Engineering Department, Federal University of Santa Catarina (UFSC), Materials Laboratory (LABMat), Rua Delfino Conti, S/N, Trindade, Florianópolis, 88040-900, Brazil; Salinas-Barrera V., Grupo de Investigación en Física Aplicada, Instituto de Ciencias Aplicadas, Facultad de Ingeniería, Universidad Autónoma de Chile, Av. Pedro de Valdivia 641, Providencia, Santiago, Chile; Aguilar C., Departamento de Ingeniería Metalúrgica y de Materiales, Universidad Técnica Federico Santa María, Av. España 1680, Valparaíso, 2340000, Chile; Dal'Maz Silva W., Institut Jean Lamour – UMR CNRS-Université de Lorraine, 7198, Parc de Saurupt, Nancy, 54011, France; Binder C., Mechanical Engineering Department, Federal

University of Santa Catarina (UFSC), Materials Laboratory (LABMat), Rua Delfino Conti, S/N, Trindade, Florianópolis, 88040-900, Brazil; Klein A.N., Mechanical Engineering Department, Federal University of Santa Catarina (UFSC), Materials Laboratory (LABMat), Rua Delfino Conti, S/N, Trindade, Florianópolis, 88040-900, Brazil

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References

Breme J., Et al., Titanium Titanium Alloys, pp. 423-451, (2005); Rho J.Y., Et al., Med. Eng. Phys., 20, 2, pp. 92-102, (1998); Neto F.C., Et al., Metals, 12, (2022); Lascano S., Et al., Appl. Sci., 9, (2019); Li J.P., Et al., Biomaterials, 28, pp. 4209-4218, (2007); Caparros C., Et al., J. Mech. Behav. Bio. Mater., 39, pp. 79-86, (2014); Hollister S.J., Adv. Mater., 21, pp. 3330-3342, (2009); Bose S., Et al., Acta Biomater., (2017); Torres-Sanchez C., Et al., Mater. Sci. Eng.: C, 77, pp. 219-228, (2017); Jian X., Et al., Mater. Design, 88, pp. 132-137, (2015); Daudt N.F., Et al., Mater. Lett., 141, pp. 194-197, (2015); Daudt N.F., Et al., J. Mater. Process. Technol., 239, pp. 202-209, (2017); Daudt N.F., Et al., Mater. Lett., 231, pp. 163-166, (2018); Klein A.N., Et al., Plasma Sci. Technol., 15, 1, pp. 70-81, (2013); Gibson L.J., Ashby M.F., Proc. R. Soc. A: Math. Phys. Eng. Sci., 382, 1782, pp. 43-59, (1982)

Correspondence Address

F. Cavilha Neto; Mechanical Engineering Department, Federal University of Santa Catarina (UFSC), Materials Laboratory (LABMat), Florianópolis, Rua Delfino Conti, S/N, Trindade, 88040-900, Brazil; email: francisco.c.n@labmat.ufsc.br

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