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AISI 310 stainless steel formed by gelcasting: An alternative manufacturing method

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The gelcasting process is a liquid forming technique that allows the achievement of compacts with high solids concentration and small amounts of binders. Although it was developed almost 30 years ago for ceramic systems, its use in powder metallurgy is rather incipient. Data related to mechanical properties of gelcast metallic samples are scarce, particularly at high temperatures. This could possibly be attributed to the fact that metallic particles are generally denser and larger than ceramic particles, leading to fast sedimentation in liquid media. Nonetheless, the settling of particles can be delayed by using a suspending agent, such as a water-soluble long chain polymer. This work evaluates the microstructure and the yield strength under compression at room temperature and at 800°C of vacuum sintered specimens prepared with HK-30 stainless steel powder (AISI 310, D50 = 10µm), manufactured by gelcasting process. The microstructure analysis involved the measurement of grain size along the vertical axis of cylindrical specimens, with special attention to the effect of particles settling, and was conducted using scanning electron microscopy (SEM), optical microscopy, and X-ray diffraction. All parts were vacuum sintered in a single batch at 1280°C, in order to avoid the influence of this condition on the results. Particles settling before gelation step can directly impact on mechanical properties, which would be an undesired effect caused by compaction gradient. Yield strength was compared with literature data of the same stainless steel, manufactured by casting. At room temperature, specimens presented the same average yield strength as the same stainless steel manufactured by casting, of 270 MPa. At 800°C, they presented 105 MPa of average yield strength. The settling effect was assessed considering the position where the specimen was taken (from the top or the bottom of the cylinder mold) and was negligible: both density and yield strength did not vary significantly along the vertical axis. These results show that the gelcasting process can be used with metal powders, even when the parts are big in height, provided that a suspending agent is used to prevent particles settling.