The effect of ultrasonic vibration on the isostatic pressing of polymer bonded melamine powder

Kun Yang[1], Kezhen Lv [1], Chao Han [1],[1]Institute of Chemical Materials, China Academy of Engineering Physics, China, People's Republic

Background, Motivation and Objective

Isostatic pressing (IP) was an important powder-processing route for the manufacture of high-quality shaped components. Still, the higher heterogeneity and the lower densification were the challenging issues. Power ultrasonic has been shown to be effective at reducing friction force and improving densification, and the purpose of this study was to apply power ultrasonic to the isostatic pressing process of polymer bonded melamine (PBm) powder in order to improve mechanical properties and densification. Besides, an ultrasonic vibration assisted isostatic pressing (UIP) technology was expected to be developed.

Statement of Contribution/Methods

An ultrasonic vibration assisted isostatic pressing system with controlled radial and axial direction transducers was designed and fabricated. The temperature and pressure in the vessel were measured online, and the effect of the crystal size, binder category, rubber bag thickness and ultrasonic parameters on the porosity, the mechanical and microstructural properties of the compact were investigated using various characterization techniques, such as SEM, Compression test, Brazilian test, SANS (Small Angle Neutron Scattering).

Results/Discussion

The extruded PBm powder which couldn't be consolidated by conventional isostatic pressing method was shaped fully by UIP, it seemed that ultrasonic vibration could transmit from the vessel wall to the PBm powder and improve densification. Application of ultrasound during isostatic pressing made it possible to decrease compact porosity, typically by 30% or more, at 130 MPa, and the decrease of porosity was proportional to the ultrasonic output power. The mechanical properties test showed that ultrasonic vibration increased the compression and tensile strength of PBm compact. SANS data analysis suggested that the interface between crystal particles was smooth, and there was no fractal-like structure in the UIP compacts. In addition, the surface area at the interface of crystal and binder was found to decrease with ultrasonic vibration applied, and a large percentage decrease of surface area could be achieved by increasing isostatic pressure, which indicated that the ultrasonic wave could be coupled to the PBm powder more effectively with higher isostatic pressure applied.

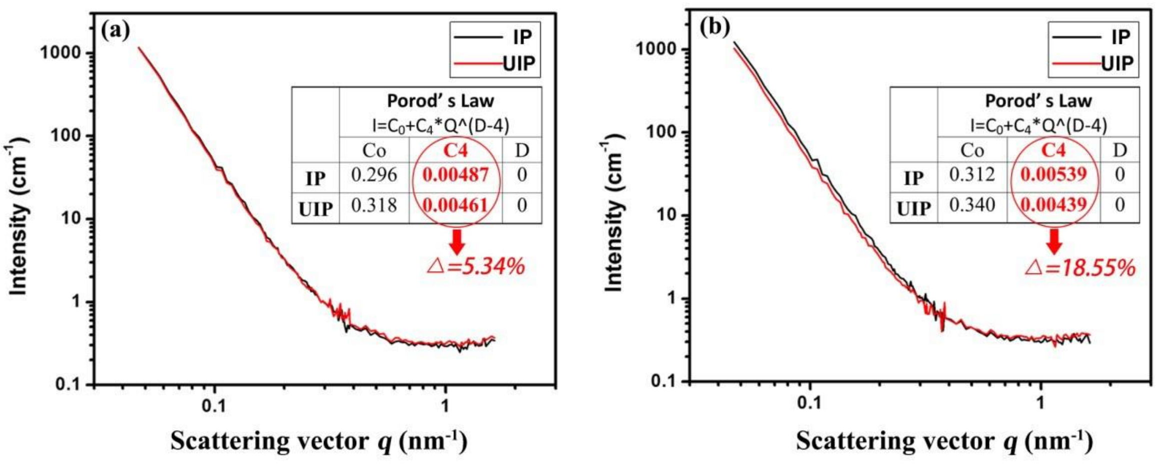

Fig. 1. Representative SANS curves of the PBm compacts for different isostatic pressure (a) 80MPa and (b) 130MPa. For clarity, C_4 was proportional to the total surface area at the interfaces.