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Constraints on stable iron phases at inner core condition from calculation of seismic properties of untextured crystal aggregates

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The top of the inner core is an important region for the dynamics of the inner core but also for the whole dynamics of the Earth. Indeed, thermal and compositional effects related to the crystallisation of the inner core strongly influence the geodynamo and Earth's cooling. P waves propagating in the inner core favor an isotropic layer with a strong attenuation which could be related to a disordered crystalline structure. Moreover, this strongly scattering layer is suggested by the PKiKP coda composed of waves wich are backscattered from the core. Because wave scattering is more efficient when the size of scatterers and the wavelength match, diffuse waves offer acces to the small heterogeneities at the top of the inner core. The current interpretation of the scattered signals has been based on the use of the single-scattering approximation (Born). We propose to further develop the multiple scattering theory using the Dyson's equation to model the attenuation of seismic waves in a statistically isotropic medium. Thus, we represent the top of the inner core as a disordered iron crystalline structure. Using laboratory measurements and ab initio calculations on the elastic properties of cubic and hexagonal iron, we can estimate the seismic waves properties: attenuation, velocity dispersion and diffusion. These properties are strongly dependent on the anisotropic behavior of a single crystal of iron : the attenuation varies over several orders of magnitude depending on the iron model. Our calculations are compared to seismic measurements on PKP(DF) attenuation in order to obtain an estimate of the size of heterogeneities at the top of the inner core. Finally, we give constraints on the elastic properties of the iron phase at the top of the inner core.