Things to keep in mind so that your scientific writing is logically structured, precise, and concise:

(1). **Use paragraphs to maintain a logical structure**

Every paragraph should contain roughly one idea + supporting evidence for that idea, if possible, and *this idea should be presented as concisely as possible*

- **paragraph 1**
  - Idea 1, supporting examples/references, logical transition to next idea

- **paragraph 2**
  - Idea 2, supporting examples/references, logical transition to next idea

- etc., etc.
The high-pressure and temperature phase transition of dioxides is of fundamental interest in solid-state physics, chemistry, and geosciences. In many dioxides, TiO$_2$ is well known as an important wide-gap oxide semiconductor with various industrial applications such as electrochemical solar cells and photocatalyst due to the characteristic high refractive index [1–9]. Apart from those technological aspects, high-pressure transformations of TiO$_2$ have attracted special attention as a low-pressure analog of SiO$_2$, the most abundant component of the Earth’s mantle. A number of experimental and theoretical studies have revealed many crystalline polymorphs of TiO$_2$ at high pressures and high temperatures [10–14]. At ambient conditions, rutile is the most stable phase of TiO$_2$. Anatase and brookite are also known as natural minerals. All of these phases transform to an α-PbO$_2$-type, to an orthorhombic-I-type, then finally to a cotunnite-type structure at approximately 50 GPa [11,14]. The cotunnite-type polymorph is identified as the highest-pressure phase, as in many dioxides [15]. Although the analogy of the phase change to the cotunnite structure was applied to TiO$_2$ [16,17], a very recent *ab initio* study predicted a different phase transition from the pyrite-type structure to an unexpected Fe$_2$P-type structure (hexagonal, space group $P6_2m$) (Fig. 1) at 690 GPa, bypassing the cotunnite-type phase stability at low temperature [18]. Since no dioxides or difluorides with this crystal structure were reported, physical and chemical properties of this new class of oxide are still unknown. Although the extremely high transition pressure predicted in SiO$_2$ seems unreachable in the laboratory, TiO$_2$ shows significantly lower transition pressures. For instance, the α-PbO$_2$ phase stabilizes at ~10 Gpa in TiO$_2$, while the same phase at 100 GPa in SiO$_2$. High-pressure behavior of TiO$_2$ is therefore a key to understanding the rich polymorphism in the metal dioxide systems, in particular, the post-cotunnite phase relations. However, all the studies performed on TiO2 were limited below 100 GPa, and no post-cotunnite phase has been identified. In this study, we investigate the applicability of the Fe$_2$P-type structure to TiO$_2$,
The high-pressure and high-temperature phase transitions of dioxides are of fundamental interest in solid-state physics, chemistry, and the geosciences. In particular, because of its high refractive index [1-9], TiO$_2$ is an important wide-gap oxide semiconductor for various industrial applications, such as electrochemical solar cells and photocatalysts. Additionally, high-pressure transformations of TiO$_2$ have attracted special attention as a low-pressure analog of SiO$_2$, the most abundant component of the Earth’s mantle.

Previous experimental and theoretical studies reveal many crystalline polymorphs of TiO$_2$ at high pressures and high temperatures [10–14]. Rutile is the most stable phase of TiO$_2$ at ambient conditions, but TiO$_2$ exhibits a structural phase transition from orthorhombic-I-type to cotunnite-type structures at approximately 50 GPa [11,14]. Cotunnite was previously reported to be the highest pressure phase of TiO$_2$ [15]. However, a recent \textit{ab initio} study of TiO$_2$ predicted a transition from the pyrite-type structure to an Fe$_2$P-type structure (hexagonal, space group $P6_2\overline{m}$) (Fig. 1) at 690 GPa. This transition bypasses the cotunnite-type phase stability at low temperatures [18]. Unfortunately, because no dioxides or difluorides with the high pressure Fe$_2$P-type crystal structure have been reported, the physical and chemical properties of the high pressure structural phase of oxides are still unknown.

Studying the high-pressure structural phases of TiO$_2$ is key to understanding the rich polymorphism in the metal dioxide systems. TiO$_2$ exhibits significantly lower transition pressures to post-cotunnite phases than other dioxides. For instance, the α-PbO$_2$ phase stabilizes at ~10 GPa in TiO$_2$, while the same phase stabilizes at 100 GPa in SiO$_2$. However, all the studies performed on TiO$_2$ have been limited to 100 GPa, and as yet no post-cotunnite phases have been identified. In this study, we theoretically and experimentally investigate the high-pressure structural phases of TiO$_2$, in particular to determine if this material exhibits a Fe$_2$P-type structure at high pressures.
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