SYNERGISTIC EFFECTS OF MICROWAVE-LASER HYBRIDIZATION AND ITS APPLICATION TO CERAMICS SINTERING

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Mixing of different wavelengths of electromagnetic radiations is, in general, beneficial for the enhancement of radiation effects. A new hybrid process has been developed by replacing the by replacing all but one laser in the existing simultaneous multiple laser process (SIMPLE). The SIMPLE process uses a combination of excimer, CO_2 and Nd-YAG laser for surface modification of ceramics. In the present procedure, we replace CO_2 and Excimer by 2.45 GHz microwave energy and explore the hybridization of microwave and Nd-YAG (1.06 μm) laser energies. The combination of these energies has produced synergistic effects and the interaction is dependent up on microwave preheat temperature, material, laser power, pulse energy. The effect can be efficiently used to rapidly sinter ceramic materials such as 3Y-TZP and ZnO. For 3Y-TZP, various laser power levels namely 90 W, 180 W and 270 W with different pulse frequencies (10 Hz and 94 Hz) and pulse energies (1 J/pulse and 10 J/pulse) have been used. Adequate conditions for sintering have been achieved only after many trial and error procedures to yield crack-free samples. Densities of 90% and above could be achieved in less than 3 minutes (180 seconds) of laser heating. Comparison studies have been made with microwave sintered specimens. Although, the density values for microwave and hybrid sintered are nearly the same, the sintering time involved in the microwave process is several times higher than the hybrid sintered process. The microwave sintered specimens had nanocracks, which are missing in the case of laser-microwave hybrid sintered samples. Also, "zero grain growth" has been observed in hybrid sintering mainly attributed to the rapidity and the "pulse hammering effects. Similar synergistic and sintering studies have also been carried out for ZnO ceramics, which will be discussed in greater detail.