Supporting Information for:

Simultaneously high fracture toughness and transverse rupture strength in ultrafine cemented carbide

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1. Back-scattered electronic image of the present WC-10wt.%Co bulk

As shown in Fig. S1, there is a homogeneous distribution of the binder phase, as exhibited by the dark contrast in the SEM image below.

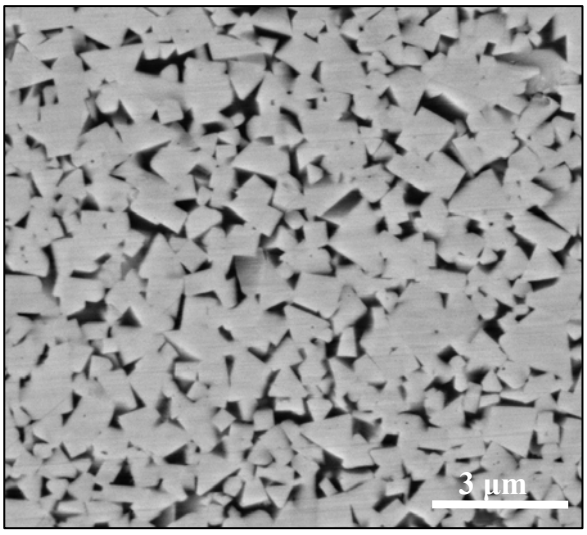

Fig. S1 SEM micrograph of the present WC-10wt.%Co bulk specimen

2. Properties of the present WC-10wt.%Co bulk materials

The porosity was analyzed by quantitative metallographic method on the polished surface according to ISO 4505 standard, where A00, A02, A04, A06 codes correspond to 0.02, 0.06, 0.2, 0.6 vol.% porosity, respectively (for pore sizes below 10 μm). The density of the specimens was measured by the

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Archimedes method. The hardness was measured by the Vickers hardness tester with a load of 30kg according to the ISO-3878 standard. The fracture toughness was determined based on the measurements on the length of cracks generated by the Vickers indentation and calculations with the equation $K_{IC} = 0.0028(HV\frac{P}{L})^{1/2}$ [1], where *HV* is the indentation hardness, *P* is the indentation load, and *L* is the total crack length.

The K_{IC} measurements by this method are very sensitive to the surface stress state of the specimen. Thus, it is important to prepare a testing surface to minimize the residual compression stress [2]. For this reason, preparation of the samples was carefully carried out, using fine grinding conditions, followed by prolonged times of polishing by successive fine diamond paste [3]. In this study, the indentation toughness was evaluated with at least five indentations on each specimen.

The TRS was measured according to the standard of ISO3327:2009 with dimensions of 20×6.5×5.25 mm^3.

Table S1 Properties of the present WC-Co specimen

Material \ Properties	Porosity	Relative density (%)	HV_{30} (kgf/mm^2)	K_{IC} ($MPa{\cdot}m^{1/2}$)	TRS (MPa)
WC-10.%Co	A02B00C00	99.99	1537	15.93	4260

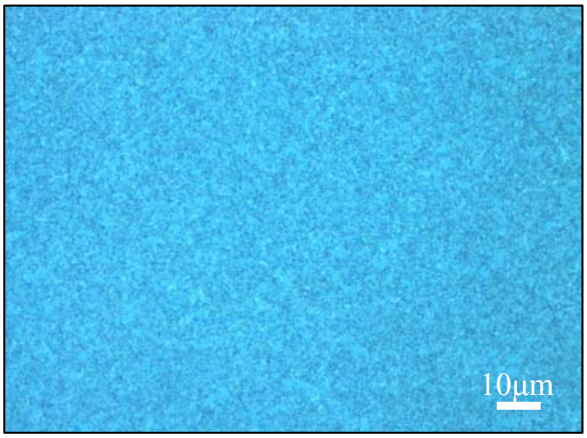

Fig. S2 Optical micrograph of the present WC-10wt.%Co bulk

3. Properties of all the tested WC-10wt.%Co samples

Table S2 Mechanical properties of all the tested WC-10wt.%Co specimens

Properties / NO.	HV_{30} (kgf/mm^2)	$\bar{x} \pm s$	K_{IC} ($MPa \cdot m^{1/2}$)	$\bar{x} \pm s$	TRS (MPa)	$\bar{x} \pm s$
1	1537		15.93		4260	
2	1520		15.32		4140	
3	1550	1549±22	14.40	14.98±0.78	4400	4218±134
4	1577		13.97		4250	
5	1560		15.28		4044	

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[2] M.T. Laugier. *J. Mater. Sci. Lett.,*1987,6,897.

[3] J.M. Sanchez, A. Ordoñez, Gonzalez. *Int. J. Refract. Met. Hard. Mater.*, 2005,23,193.